THE ORDOVICIAN TRILOBITE FAUNAS OF SOUTH SHROPSHIRE, III

BY

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THE ORDOVICIAN TRILOBITE FAUNAS OF SOUTH SHROPSHIRE, III

By WILLIAM THORNTON DEAN

SYNOPSIS

This paper is the third of a series of four dealing with the Caradoc trilobites of south Shropshire. Those described belong to fifteen genera or subgenera, of which one, *Remopleurella*, is new, and twenty-six species or subspecies, of which five are new. The trilobites comprise the gonatoparian family Calymenidae, together with all the known opisthoparian forms, belonging to nine families.

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Family Calymenidae Burmeister, 1843

Genus ***FLEXICALYMENE*** Shirley, 1936

Type species. *Calymene Blumenbachii* var. *Caractaci* Salter, 1865 by original designation of Shirley (1936 : 395).

Flexicalymene acantha Bancroft

(Pl. 37, figs. 1, 3–6, 14)

1949. *Flexicalymene acantha* Bancroft, p. 305, pl. 11, figs. 29, 30.
1958. *Flexicalymene acantha* Bancroft : Dean, p. 219.

Bancroft's original description was founded on two specimens, the holotype cranidium and a paratype pygidium, both probably immature. A few large topotype cranidia have been collected and these show slight differences from the holotype. The anterior border is somewhat shorter proportionately and a little less steeply upturned, the frontal glabellar lobe is more rounded, and there is a well-defined break in the glabellar outline, so that the latter narrows sharply, immediately in front of the second glabellar lobes. Where the external impression of the test is available it is seen to be practically smooth, with only occasional traces of tubercles, contrasting markedly with the almost prickly appearance of immature specimens. One specimen has been found with thorax complete (Pl. 37, fig. 14). There are thirteen segments of normal calymenid type and the surface of the axial rings and pleurae, excluding furrows, is ornamented with small tubercles ; again, the specimen represents an immature individual. The pygidium figured by Bancroft (1949, pl. 11, fig. 30) has the axis distorted by crushing so that it appears too narrow ; normally it occupies frontally about one-third of the maximum breadth. There are six axial rings, of which the sixth is poorly defined, and five pairs of furrowed pleural ribs, not six as stated by Bancroft (1949 : 305). No well-preserved pygidium of *F. acantha* has yet been found in association with the cephalon of the species, therefore some doubt must exist as to the true identity of the paratype pygidium, as another calymenid, *Gravicalymene praecox* (Bancroft), occurs in the same strata.

Horizon and Localities. In the Costonian Stage of the Coston district, near Aston-on-Clun, and at Brokenstones, near Horderley, there occur numerous calymenids which are close to Bancroft's species, and some are figured here as *Flexicaly-*

mene cf. *acantha* (Pl. 37, figs. 7, 10, 13). Such differences as exist, for example, degree of inclination of the anterior border, straightening of the normally convex margins of the glabella, and variation in the shape of the frontal glabellar lobe, could well be the result of mechanical deformation and it is not proposed to regard them as distinct from *F. acantha*. The earliest known, uncommon occurrences are in the middle Costonian of Coston but specimens are moderately abundant in the succeeding upper Costonian.

The type locality is the old cartway section near the south end of Smeathen Wood, Horderley, 250 yards west-south-west of Wood House, where the species occurs in small numbers in the lowest Smeathen Wood Beds, Harnagian Stage, *Reuscholithus reuschi* Zone. *Flexicalymene acantha* has been found neither at higher horizons, nor outside the southern part of the Caradoc district. In the northern part of the district, however, *Flexicalymene* (*s.s.*) is believed to occur in the topmost Costonian Stage, near Cressage, but the available specimens are too fragmentary to ascertain whether another species is represented ; furthermore the dominant form in the Cressage strata is *Flexicalymene* (*Reacalymene*) *pusulosa* (Shirley).

Holotype. BM. In. 42091 (Pl. 37, fig. 3).

Paratype. BM. In. 49592 (Pl. 37, fig. 4).

Discussion. For convenience the discussion of the species of *Flexicalymene* (*s.s.*) has been placed after the description of *F. cobboldi*.

Flexicalymene planimarginata (Reed)

(Pl. 37, fig. 15)

1906. *Calymene planimarginata* Reed, p. 137, pl. 17, fig. 15.
1960. *Flexicalymene planimarginata* (Reed), Whittard, p. 158. Includes full synonymy of the species.

A few pygidia have been collected from the Lower Longvillian Substage south of the Onny Valley, and the most complete is figured here.

Preserved as an internal mould it shows all the features mentioned by Harper (1947 : 167) in his re-description of the species, though comparison with the somewhat distorted topotype figured by him (Pl. 6, fig. 12) is difficult. The Shropshire specimen now illustrated is from the *Dalmanella horderleyensis* Zone, that is to say only slightly earlier than the horizon yielding the type-specimen at Ynys Galed, Caernarvonshire. Whittard (1960 : 158) has recently found the same species in west Shropshire, where it occurs earlier, in the Soudleyan Stage.

Flexicalymene caractaci (Salter)

(Pl. 38, figs. 2, 4–6, 8, 11, 12)

1865*a*. *Calymene Blumenbachii* var. *Caractaci* Salter, p. 96, pl. 9, fig. 3.
1931. *Calymene caractaci* Salter : Shirley, p. 25, pl. 2, figs. 4–6.
1936. *Flexicalymene caractaci* (Salter) Shirley, p. 395, figs. 1, 2.
1949. *Flexicalymene trigonoceps* Bancroft, p. 306, pl. 11, figs. 31, 32.

Specimens of this well-known species are common in the Caradoc Series of south Shropshire, but records of its existence outside the district are suspect and its true

distribution in the Anglo-Welsh area is by no means well known, though its apparent absence is likely to result from the lack of the appropriate strata over much of Wales.

Flexicalymene caractaci was re-described by Shirley (1931 : 25) using Salter's type-material, which comprises a large slab of highly fossiliferous, decalcified sandstone. The lithology is typically that of the Upper Cheney Longville Flags, of Marshbrookian age, and this is confirmed by the fauna which includes, in addition to *F. caractaci*, abundant *Dalmanella wattsi* (Bancroft) and *Broeggerolithus transiens* (Bancroft). The specimen illustrated by Shirley (1931, pl. 2, fig. 4) and refigured here (Pl. 2, fig. 6) is now chosen as lectotype as it corresponds best with Salter's original illustration. Little need be added to Shirley's detailed description, but it may be noted that the anterior border is somewhat variable in length, and that its angle of inclination may be dependent on the state of preservation. For this reason Bancroft's *Flexicalymene trigonoceps*, said by him to have an anterior border less steeply inclined than that of *F. caractaci*, is now considered to fall within the limits of variation of the latter species. The earliest undoubted occurrences in south Shropshire are in the lowest Marshbrookian Stage, the *Dalmanella wattsi* Zone, at which level it is to be found in abundance at several localities, but fragmentary evidence from the *Kjaerina typa* Zone of the Upper Longvillian Substage in the Onny Valley suggests that it may have appeared there somewhat earlier. *F. caractaci* is generally found wherever the strata of the *Dalmanella unguis* Zone crop out ; in the topmost third of the Marshbrookian, the *Onniella reuschi* Zone, the species is noticeably less common, and as yet it has been found neither in the overlying Actonian Stage nor co-existing with species of *Onnicalymene*.

Lectotype. GSM. 47698 (Pl. 38, fig. 6).

Flexicalymene cobboldi sp. nov.

(Pl. 38, figs. 1, 3)

Diagnosis. *Flexicalymene* (*s.s.*) with relatively short, well-rounded glabella. Anterior border long, steeply inclined frontally, and convex forwards in plan. Eyes situated opposite second glabellar lobes and furrows.

Description. The cranidium is moderately convex both longitudinally and transversely, with the maximum breadth twice the median length. The glabella is plump and short, about as broad as long, its outline subparabolic. The frontal glabellar lobe is small and short, only about one-seventh of the glabellar length, broadly rounded frontally and defined posteriorly by short (*tr.*), shallow, first glabellar furrows slightly divergent posteriorly, parallel to the small, ovoid, first glabellar lobes. The second glabellar lobes are larger, subcircular in plan, about half the length (*exsag.*) of the third lobes, which are of the " cat's ear " form described by Shirley (1931 : 20, 26). The second glabellar furrows are deep, widening (*exsag.*) adaxially and showing traces of branching. The third glabellar furrows are somewhat wider, deeper and distinctly bifid, the anterior branches being the shorter, continuing across the bases of the second lobes, whilst the posterior branches end opposite the mid-points of the third lobes, though there is a suggestion of their continuation as shallow grooves across the neck-like structures connecting the lobes

to the median glabellar lobe. The unfurrowed median lobe of the glabella is broad, with almost no development of what Shirley (1936 : 386) termed intermediate lobes. The axial furrows are broad, curved, gently convergent forwards, shallowing slightly opposite the second glabellar lobes. The anterior border is long, well rounded in plan, and of scoop-like form, steeply inclined forwards. The palpebral lobes, incompletely known, are sited in line with the second glabellar lobes and furrows. The remainder of the cranidium contains no diagnostic features, and is identical with that of *Flexicalymene caractaci*, a closely-related species. The librigenae, hypostoma, thorax and pygidium are not known.

Horizons and localities. The holotype is from the Upper Longvillian Substage, *Kjaerina bipartita* Zone, by the south-eastern side of the road between Horderley and Marshbrook, 420 yards north-east of the building known as Crosspipes. At this point the specimen was collected from grey-green mudstones which are interbedded with limestone lenses containing *Heterorthis alternata* (J. de C. Sowerby), the whole being grouped together as the " *Alternata* Limestone ". The paratype, the only other specimen known, is from the Marshbrookian Stage, *Dalmanella unguis* Zone, at Marsh Wood Quarry, half-a-mile south of Marshbrook Station. The fossil band containing this specimen did not yield any other specimens of *Flexicalymene*, though *F. caractaci* has been found in abundance at other levels in the same quarry.

Holotype. BM. In. 55448 (Pl. 38, fig. 3).

Paratype. BM. In. 50762 (Pl. 38, fig. 1).

Discussion. The stratigraphically earliest known species of *Flexicalymene* (*s.s.*) in south Shropshire is *F. acantha*, the glabellar outline of which, narrowing sharply in front of the second glabellar furrows, is remarkably suggestive of that found in *Flexicalymene cambrensis* (Salter, 1865), a Llandeilo species which has been refigured by Shirley (1931 : 20, pl. 1, figs. 11–15), and the two forms may be related. However, the anterior border of *F. acantha* is noticeably the shorter of the two, whilst the palpebral lobes of *F. cambrensis* are situated farther forwards than in the Harnagian species.

In the collections of the Geological Survey & Museum there are two specimens labelled " *Calymene fatua* ", a manuscript name proposed by Salter but never published. One of these specimens, numbered 19603, is a typical, though distorted, cranidium of *Flexicalymene acantha* from " Horderley ". The other is an unidentifiable, damaged cranidium, 19604, apparently a *Flexicalymene* or *Reacalymene*, alleged to be from " Gretton ". This locality is probably incorrect, as only strata of Marshbrookian or Actonian age crop out in the vicinity of Gretton village, whereas the matrix of the specimen suggests rather a derivation from the Chatwall Flags, of Soudleyan age.

Calymene incerta Barrande (1852 : 568, pl. 19, figs. 30, 36) was stated to occur at a number of localities in Bohemia, and the illustrated specimens show some variation in the proportions of the glabella, so that more than one form may be present. The species may be referred to *Flexicalymene* (*s.s.*), and specimens in the Barrande Collection at the British Museum (Nat. Hist.) from Zahoržan, one of the localities listed in the original description, show the anterior border to be relatively short, suggesting a comparison with species such as *F. acantha* and *F. planimarginata*,

rather than with *F. caractaci* and *F. declinata* (see later). In general, *Flexicalymene incerta* appears to be larger than any of the Anglo-Welsh species, with a glabellar outline much broader frontally than either *F. acantha* or *F. planimarginata*, although one of the specimens figured by Barrande (1852, pl. 19, fig. 32 only) has a glabella reminiscent of *F. acantha*. According to Barrande (1852 : 569), *F. incerta* is accompanied by *Trinucleus ornatus* (now *Onnia ornata* Sternberg sp.) and *Calymene pulchra* (now *Pharostoma pulchrum* Beyrich sp.), and is unlikely to be later than Caradoc in age.

The species to which *Flexicalymene caractaci* bears, perhaps, the strongest resemblance is *F. declinata* (Hawle & Corda), described originally from the Ordovician of Beraun (Hawle & Corda, 1847 : 87), but figured first by Barrande (1852 : 570, pl. 43, figs. 53–58). The glabellar outline is closely similar in both species, but the eyes of *F. declinata* are situated farther forwards, opposite the first glabellar lobes, whilst the outline of the anterior border is less well-rounded than that of *F. caractaci*. According to Barrande (1852 : 572), *F. declinata* is found in company with *Remopleurides radians* (now *Amphitryon radians* Barrande sp.) and *Trinucleus Bucklandi* (now *Tretaspis granulata* Wahlenberg sp.), species which suggest an Ashgill age.

Flexicalymene caractaci and *F. cobboldi* may readily be separated from the earlier *F. acantha* and *F. planimarginata* by their longer anterior border as well as by the glabellar outline, whilst the glabella of *F. caractaci* is longer than that of *F. cobboldi*. The short glabella of the last-named species is not unlike that of *Flexicalymene brevicapitata* Portlock sp. (Shirley, 1931 : 28, pl. 2, figs. 9, 10) from, probably, the Killey Bridge Beds of Tyrone, but the latter lacks definite first glabellar lobes and the eyes are situated slightly farther forwards than in the Shropshire trilobite.

Subgenus ***REACALYMENE*** Shirley, 1936

TYPE SPECIES. *Reacalymene limba* by original designation of Shirley (1936 : 395).

Flexicalymene (Reacalymene) pusulosa (Shirley)

(Pl. 37, figs. 9, 11, 12)

1936. *Reacalymene pusulosa* Shirley, p. 407, pl. 29, figs. 9, 10.
1958. *Reacalymene pusulosa* Shirley : Dean, pp. 198, 218.
1962. *Flexicalymene* (*Reacalymene*) *pusulosa* (Shirley) Dean, p. 113.

Numerous specimens corresponding in all details with Shirley's original description of the species have been found in the topmost subdivision, the *Harknessella subquadrata* Zone or Limestone, of the Costonian Stage in the Harnage District, where it occurs at several localities. In the southern part of the Caradoc District, several miles south of Harnage, the Costonian strata become less calcareous and more arenaceous than at Harnage and have not yielded material which can satisfactorily be assigned to *F.* (*R.*) *pusulosa*. The evidence suggests that the species has a somewhat restricted horizontal as well as vertical distribution, and that farther south it is replaced by *Flexicalymene acantha* Bancroft. Although Shirley stated that the pygidium of *F.* (*R.*) *pusulosa* possesses four pleural ribs and six axial rings, further

collecting shows that some specimens may have five pleural ribs and traces of a seventh axial ring.

HOLOTYPE. This specimen, a cranidium, was originally part of the E. S. Cobbold collection, housed in the Shrewsbury Museum, but has since been transferred to the British Museum (Nat. Hist.) where it is numbered In. 50780 (Pl. 37, figs. 9, 11).

LOCALITIES. The holotype is from the disused quarry near the eastern end of Black Dick's Coppice, Evenwood, whilst the other figured specimen is from the small quarry in the north-western part of Round Nursery, south of Harnage Grange.

Flexicalymene (Reacalymene) cf. *limba* (Shirley)

(Pl. 37, fig. 16)

1936. *Reacalymene limba* Shirley, p. 409, pl. 29, figs. 11–13.
1960*a*. ? *Reacalymene pusulosa* Shirley : Dean, p. 167.
1961. *Reacalymene limba* Shirley : Whittard, pl. 22, fig. 5.

An incomplete cranidium preserved as an internal mould resembles the species described by Shirley in all essentials, as far as can be ascertained. Shirley distinguished *Reacalymene limba* from *R. pusulosa* by the former's possession of a less convex glabella and longer " preglabellar field " (=anterior border). He also pointed out that *R. limba* lacked the so-called " supplementary " furrows on the glabella just behind the hypostomal pits, and such furrows appear to be absent from the present specimen. In addition it may be stated that the sides of the glabella are more convergent forwards in *F.* (*R.*) *limba* than in *F.* (*R.*) *pusulosa*, resulting in a distinctive, triangular appearance.

HORIZON AND LOCALITY. The so-called " *Glyptocrinus* Flags ", Soudleyan Stage, probably *Broeggerolithus broeggeri* Zone, at the small, disused, road-side quarry 150 yards north-east of Chatwall Farm, Chatwall. Shirley (1936 : 409) believed, though with reservations, that the holotype of *F.* (*R.*) *limba* originated from the Rhiwlas Limestone, Ashgill Series, of the Bala District, but recently Whittard (1960 : 158) has recorded the species from the Shelve Inlier, at the same horizon as the present specimen. Despite extensive collecting the species has not been found at any other horizon in south Shropshire, and Shirley's record (1936 : 408) of rare *Reacalymene pusulosa* in the *Glyptocrinus* Flags may refer, in fact, to forms such as that now figured.

Flexicalymene (Reacalymene) horderleyensis sp. nov.

(Pl. 37, figs. 2, 8 ; Pl. 40, figs. 7, 8)

?1947. *Flexicalymene* sp. nov., Harper, p. 168, pl. 6, fig. 10.
1958. *Reacalymene* sp. nov., Dean, p. 221.

DIAGNOSIS. Species of *Reacalymene* characterized by subtriangular glabella with short frontal lobe, and long, steeply inclined anterior border with low, transverse ridge.

DESCRIPTION. The species is known, so far, from only three isolated cranidia, two of them external moulds, the other an internal mould. The glabella is slightly longer than broad, roughly subtriangular in plan with almost straight lateral margins

converging forwards at about 35 degrees to a short, broadly rounded, frontal glabellar lobe. There are three pairs of lateral glabellar lobes, those of the basal pair the largest, broadly oval in plan, slightly divergent forwards, and bluntly pointed anterolaterally. The second glabellar lobes are about half the size of the third pair, oval in plan, broadly divergent forwards and parallel to the lobes of the first pair, which are short and subrectangular. The first glabellar lobes are separated from the frontal glabellar lobe by short, shallow, first glabellar furrows which are parallel to the long axes of the first lobes. The second glabellar furrows run parallel to those of the first pair, but are deeper, bifurcating slightly so that the posterior branch is the longer. The third glabellar furrows are more markedly bifid, the anterior branches short, curving around the second glabellar lobes, the posterior branches running backwards and ending just short of the occipital furrow ; the two branches are separated by a small, convex lobe-like swelling. All the glabellar lobes and furrows end in-line adaxially, leaving a median body which is roughly parallel sided and occupies a little less than half the breadth of the glabella. The anterior border is long, convex forwards medially, slightly ridged posteriorly on the external mould (Pl. 37, fig. 2), though apparently smooth on the internal mould (Pl. 40, fig. 8) ; it is separated from the preglabellar field by a shallow, anterior border furrow. What may be described as the preglabellar field is short (*sag.*), gently inclined forwards, expanding laterally, truncated by the well-impressed preglabellar furrow which is continuous with the deep, narrow axial furrows. The occipital furrow is shallow and transversely straight medially, deepening laterally, at the same time becoming convex backwards as it circumscribes the third glabellar lobes. Similarly, the occipital ring is transversely straight and of uniform length (*sag.*) medially, shortening laterally where it forms a pair of poorly defined occipital lobes, strongly divergent forwards, and indistinctly separated from the posterolateral parts of the fixigenae. The posterior border furrow is broad (*exsag.*), straight, of uniform and moderate depth, delimiting a posterior border which is narrow (*exsag.*) adaxially, broadening towards the genal angles. The anterior portions of the fixigenae are of uniform breadth, almost half that of the frontal glabellar lobe, and parallel-sided as far as the palpebral lobes, whilst the posterior portions are steeply declined. The palpebral lobes are laterally convex in plan, situated opposite the second glabellar lobes, with poorly-defined eye-ridges running from the anterior ends of the lobes to end at the axial furrows opposite the first glabellar lobes. The facial suture is of characteristic calymenid type, the anterior branches converging gently from the eyes to cut the anterior margin at points which lie longitudinally between the palpebral lobes and the axial furrows, whilst the posterior branches curve backwards from the eyes, at first gently and then more strongly to the genal angles. The surface of the test is poorly known from only two external moulds, but appears to be finely granulate.

The librigenae, hypostoma, thorax and pygidium are not known.

Horizon and localities. The holotype and one paratype are from the Lower Longvillian Substage, zone of *Dalmanella indica* and *D. lepta*, at the outcrop inside the south-eastern corner of Rookery Wood, south-east of Horderley. The remaining paratype is from a similar horizon at the small disused quarry just west of the

western end of Rookery Wood. Fragmentary evidence of what may prove to be the same species has been obtained from the underlying *Dalmanella horderleyensis* Zone at Long Lane Quarry, three-quarters of a mile north-west of Craven Arms.

HOLOTYPE. BM. In. 50656 (Pl. 37, figs. 2, 8).

PARATYPES. BM. In. 49559, BM. In. 52103 (Pl. 40, figs. 7, 8).

DISCUSSION. *Flexicalymene* (*Reacalymene*) *horderleyensis* bears a general resemblance to *F.* (*R.*) *limba*, from which it is distinguished by its longer, more steeply upturned anterior border, and shorter frontal glabellar lobe. In the Welsh Borders the known species of *Reacalymene*, namely *pusulosa*, *limba* and *horderleyensis*, derive successively from Costonian, Soudleyan and Lower Longvillian strata, and form a morphological series, with a progressive increase in the length of the anterior border, and in the degree of convergence of the axial furrows.

The internal mould of a calymenid cranidium described and figured by Harper (1947 : 168, pl. 6, fig. 10) as *Flexicalymene* sp., from the Lower Longvillian of Ynys Galed, North Wales, has apparently undergone some tectonic deformation, but nevertheless bears a general resemblance to *F.* (*R.*) *horderleyensis*, particularly in the glabellar outline and long anterior border (compare Pl. 4, fig. 7). The two may be synonymous, but a final decision must await the collection of additional Welsh material.

Calymene croneisi Roy, 1941, from the Ordovician, possibly Trenton, of Baffin Island, was recently redescribed by Whittington (*in* Miller *et al.*, 1954 : 147, pl. 62, figs. 13–15) and assigned to *Flexicalymene*, though he noted that the anterior border is ridged as in *Reacalymene*. *Flexicalymene* (*Reacalymene*) *croneisi* bears a general resemblance to the Anglo-Welsh species, but is particularly distinguished by the forward position of the palpebral lobes, opposite the second glabellar furrows and part of the first glabellar lobes. The anterior border of the North American form, like that of *F.* (*R.*) *pusulosa*, is relatively short and transversely straight, which feature easily separates it from *F.* (*R.*) *horderleyensis*, whilst the glabellar outline is narrower than that of *F.* (*R.*) *pusulosa*.

Genus ***ONNICALYMENE*** Dean, 1962

TYPE SPECIES. *Flexicalymene onniensis* Shirley, 1936 by original designation of Dean (1962 : 112).

Onnicalymene onniensis (Shirley)

(Pl. 39, figs. 2, 10, 11; Pl. 40, fig. 9)

1865. *Calymene brevicapitata* Portlock, Salter, pl. 9, fig. 7.
1936. *Flexicalymene onniensis* Shirley, p. 405, pl. 29, figs. 5–7.
1949. *Flexicalymene onniensis* Shirley : Bancroft, p. 308, pl. 11, figs. 36, 37.
1958. *Flexicalymene onniensis* Shirley : Dean, p. 224.
1959. *Flexicalymene onniensis* Shirley : Dean, pp. 200, 207.
1959. *Flexicalymene* aff. *onniensis* Shirley : Dean, pp. 202, 208.
1962. *Onnicalymene onniensis* (Shirley) Dean, p. 115, pl. 13, figs. 7; pl. 14, figs. 1, 2, 7, 10.

The species was first described by Shirley (1936) from the *Onnia gracilis* Zone of the Onnian Stage in the River Onny Valley. The most likely site of the type-locality

is the prominent, ridge-like outcrop in the river-bed about 100 yards of its junction with the stream of Batch Gutter, and at this point *O. onniensis* occurs abundantly with the zonal trinucleid. There is ample evidence that the species ranges upwards into and through the succeeding *Onnia superba* Zone, but evidence of its earlier occurrence is tenuous. Possible fragments have been found in the *Onnia* ? *cobboldi* Zone of the Onny Valley, but all the identifiable specimens of *Onnicalymene* so far collected from the underlying Actonian Stage have proved to belong to other species. Outside Shropshire *O. onniensis* occurs at Welshpool, in the *Onnia gracilis* Zone, and in the Dufton Shales of the Cross Fell Inlier, where it has an extended vertical range upwards into the Pusgillian Stage (Dean, 1962 : 115).

HOLOTYPE. GSM. RR 1940 (Pl. 39, figs. 10, 11).

Onnicalymene laticeps (Bancroft)

(Pl. 38, figs. 7, 10, 14, 15)

1949. *Flexicalymene laticeps* Bancroft, p. 307, pl. 11, figs. 33, 33*a*.
1958. *Flexicalymene laticeps* Bancroft : Dean, p. 224.
1962. *Onnicalymene laticeps* (Bancroft) Dean, p. 115, pl. 14, figs. 5, 6.

This small, easily-recognized species of *Onnicalymene* has been found at several localities in Shropshire, in both mudstones and sandstones of the Actonian Stage. *O. laticeps* has been recorded also in the Cross Fell Inlier (Dean, 1962 : 115), and may prove to be of stratigraphical value. It is readily separated from other species of the genus by its short, well-rounded glabella.

HOLOTYPE. BM. In. 42103 (Pl. 38, fig. 7).

Onnicalymene salteri (Bancroft)

(Pl. 38, figs. 9, 13)

1949. *Flexicalymene salteri* Bancroft, p. 306, pl. 11, figs. 34, 35.
1958. *Flexicalymene salteri* Bancroft : Dean, p. 224.
1962. *Onnicalymene salteri* (Bancroft) Dean, p. 113.

This species was founded on two cranidia, both of Actonian age, one, the holotype, from the northern end of the small wood west of Rose Villa, Marshbrook, the other from the locality known as Jack Slither, in the south bank of the River Onny, 45 yards west of its junction with the stream of Batch Gutter. Both specimens occur in grey, calcareous mudstones, a lithology which contains most of the known specimens, though a few have been collected from limestone bands of the Actonian in the vicinity of Jack Slither. *Onnicalymene salteri* has not yet been found in the arenaceous facies of the Actonian, such as is found at and near Acton Scott and Cardington, nor is it known to occur at any horizon other than the Actonian. It is subordinate in numbers to the contemporaneous *Onnicalymene laticeps* (Bancroft), and has not been recorded outside Shropshire.

HOLOTYPE. BM. In. 42100 (Pl. 38, fig. 9).

PARATYPE. BM. In. 42099.

Genus *GRAVICALYMENE* Shirley, 1936

TYPE SPECIES. *Gravicalymene convolva* by original designation of Shirley (1936 : 395).

Gravicalymene praecox (Bancroft)

(Pl. 39, figs. 1, 3, 9, 12–14)

1949. *Diacalymene praecox* Bancroft, p. 308, pl. 11, figs. 28, 28*a*.
1958. *Diacalymene* ? *praecox* Bancroft : Dean, p. 219.
1962. *Gravicalymene praecox* (Bancroft) Dean p. 113.

The holotype of *Gravicalymene praecox*, like the lectotype of *Flexicalymene acantha*, from the same locality and horizon, is a small immature cranidium (Pl. 39, figs. 13, 14). The photograph used by Bancroft (1949, pl. 11, fig. 28) to illustrate the species was taken obliquely from the right-hand side of the specimen ; consequently, what might appear to be a constriction of the right axial furrow is really an illusory effect produced by the convexity of the right fixigena in line with the axial furrow. In fact, the axial furrows of the holotype show no lateral constriction, and the species cannot, therefore, be placed in *Diacalymene*. Both *Diacalymene* and *Gravicalymene* have recently been discussed (Dean, 1962) and it has been shown that the earlier usage of the terms " ridged " and " roll-like " with regard to the form of the anterior border is unsatisfactory as a basis for generic differentiation, but that the form of the axial furrows is more reliable. On these grounds, therefore, *Diacalymene praecox* must be transferred to *Gravicalymene*. During recent collecting, additional topotype material has been obtained which apparently represents mature adult specimens of the species (Pl. 39, figs. 1, 3, 9, 12). All are internal moulds of incomplete cranidia, and they show little change from the holotype, though the granulation of the test found on the latter specimen seems to have disappeared when the adult stage was attained.

A cranidium from the Actonian Stage at Gretton, GSM. 19588, constituted one of the syntypes of Salter's (1865*a*, pl. 9, fig. 4 only) *Calymene Blumenbachii* var. *Caractaci* whilst another cranidium from the same locality was assigned to the same species by La Touche (1884, pl. 3, fig. 61). These stratigraphically later forms of *Gravicalymene* are undoubtedly extremely close to *G. praecox*, with which species they are compared here, though identification cannot be certain in the absence of complete, uncrushed, adult cranidia of the Harnagian species. The thorax, of characteristic calymenid form, with thirteen thoracic segments, was found in juxtaposition to both cranidium and pygidium in strata of Onnian age (Pl. 39, figs. 4, 5, 8). The pygidium is strongly convex both longitudinally and transversely, the dorsal surface of the axis being gently convex, steeply declined posteriorly. The outline of the pygidium, when viewed from above with the axis horizontal, is broadly semi-elliptical frontally, the posterolateral margins being straight, strongly divergent forwards as far as the line of maximum breadth, opposite the midpoint of the pygidium. The axis is broadest frontally, where it is equal to one-third the maximum pygidial breadth, but narrows a little backwards, and stops short of the the tip of pygidium. Excluding the articulating half-ring, there are seven well-defined axial rings, and the axial furrows are straight, slightly convergent backwards where

they are continued so as to circumscribe the terminal piece, which is of moderate size and a little less than one-quarter the length of the axis. The pleural lobes are strongly arched-down laterally, with six pairs of well-defined, evenly curved ,pleural ribs, and a seventh, less well-defined pair fused together to form a low, postaxial ridge. Each pleural rib is divided into two bands of almost equal breadth (*exsag.*) by a narrow, shallow, interpleural furrow which cuts the posterior margin of the rib at its intersection with the axial furrow.

Horizons and localities. *Gravicalymene praecox* was first described from the Smeathen Wood Beds, Harnagian Stage, *Reuscholithus reuschi* Zone, exposed in the old cartway at the southern end of Smeathen Wood, Horderley. What is probably the same form has been found, rarely, at the corresponding horizon in the north bank of Coundmoor Brook, about 1,295 yards south-west of Harnage Farm, Harnage. As noted earlier, specimens referred to *Gravicalymene* cf. *praecox* have been collected from both the Actonian and Onnian Stages. Actonian localities include the old quarry 210 yards east of Acton Scott church, and the now unavailable quarry at Quarry Field, Gretton, near Cardington (see Pl. 39, fig. 7). The only Onnian locality at which *G.* cf. *praecox* has been found is in rocks of the *Onnia gracilis* Zone, exposed in the north bank of the River Onny 100 yards east of its junction with Batch Gutter. These occurrences, at widely separated horizons within the Caradoc Series, are particularly interesting as no evidence of *Gravicalymene* has been found in the intervening strata. It may be noted, however, that in each case the appearance of the genus is associated with an influx of new faunal elements, and this, in turn, may be correlated with a marine transgression which affected much of the Anglo-Welsh area. The lower of these is the *Nemagraptus gracilis* Transgression, which continued into the overlying *Diplograptus multidens* Zone ; the higher transgression is that occurring high in the *Dicranograptus clingani* Zone, and perhaps also in the *Pleurograptus linearis* Zone, which gave rise to dark shales and mudstones, including the Nod Glas, in North Wales.

Holotype. BM. In. 42090 (Pl. 39, figs. 13, 14).

Discussion. Of the other recorded species of *Gravicalymene* in the British Ordovician, *G. jugifera* Dean (1962, pl. 13, figs. 9, 11 ; pl. 14, figs. 3, 4, 8, 9) from the Pusgillian Stage of the Cross Fell Inlier differs from *G. praecox* in having proportionately smaller basal glabellar lobes, a less quadrate frontal glabellar lobe, and an anterior border which is separated from the glabella by a broader (*sag.*), more conspicuous furrow. *Gravicalymene convolva* Shirley (1936 : 409, pl. 29, figs. 16–18) is a relatively large species which may be distinguished from *G. praecox* by its broader glabellar outline, with slightly smaller basal glabellar lobes and conspicuously shorter frontal glabellar lobe.

The trilobite figured by Størmer (1945, pl. 2, figs. 6–8) as *Reacalymene holtedahli* from Stage 4cα of Hadeland, Norway (an horizon approximately equivalent to the Pusgillian Stage) is probably best placed in *Gravicalymene* or *Diacalymene*. It may be distinguished from *G. praecox* by its narrower glabellar outline, smaller glabellar lobes, and shorter frontal glabellar lobe. One of Størmer's syntypes appears to show the second glabellar lobes in contact with the fixigenae, but, judging from the distortion of the specimen, this may well be due to mechanical causes. The pygidium of the Nor-

wegian form has fewer axial rings and pleural ribs than that described in the present paper as *Gravicalymene* cf. *praecox*.

It was claimed by Bancroft (1949 : 309) that what he called *Diacalymene praecox* was important in anticipating a form of Ashgill age, probably *D. marginata* Shirley, judging from his text. Now that *D. praecox* can be assigned to *Gravicalymene*, such a claim is without foundation, and the species probably represents nothing more than one member of a long-ranging genus. The trilobite figured by Shirley (1931, pl. 2, fig. 11) as *Calymene quadrata* ? King, from the Llandeilo Flags of South Wales, is too badly preserved for certain identification, but bears some resemblance to *Gravicalymene*, and suggests that the genus may have appeared in the Anglo-Welsh area before the beginning of Caradoc times. *Gravicalymene* had a remarkably long stratigraphical range, and has been recorded as late as the Devonian from New Zealand (Shirley, 1938).

Gravicalymene inflata sp. nov.

(Pl. 39, fig. 6)

1958. *Gravicalymene* sp. nov., Dean, p. 224.

Diagnosis. Species of *Gravicalymene* with short (*sag.*), transversely straight, anterior border. Frontal glabellar lobe moderately long, markedly quadrate in plan. Fixigenae strongly convex, almost as anteriorly broad as frontal glabellar lobe. Palpebral lobes sited opposite second glabellar furrows and anterior half of second glabellar lobes.

Description. The only available specimen is an incomplete cranidium, lacking the posterior halves of the fixigenae, but with the test preserved. The median length is about 15 mm., and the frontal breadth, as measured across the anterior portion of the fixigenae, is 17 mm.

The glabella is slightly longer than broad, approximately in the ratio 6 : 5, but the proportions are somewhat distorted by crushing of the basal glabellar lobes, which constitute the line of greatest breadth. The frontal glabellar lobe is markedly rectangular in outline, its breadth more than twice the length. There are three pairs of glabellar lobes, those of the third pair being the largest, becoming subangular anterolaterally. The second glabellar lobes are considerably smaller than those of the third pair, oval in shape with their long axes gently divergent forwards. The third lobes are of subcircular form, about half the size of the second lobes ; they are defined anteriorly by short (*tr.*), transversely straight, first glabellar furrows which widen (*exsag.*) slightly adaxially. The second glabellar furrows are at first transversely straight from the axial furrows, but quickly bifurcate, the anterior branch so formed being short, and the posterior branch longer, extending backwards until opposite the mid-points of the second glabellar lobes. The third glabellar furrows extend backwards from the axial furrows for almost the length (*tr.*) of the second glabellar lobes before bifurcating, the shorter, anterior branch then running forwards towards, but not meeting, the posterior branch of the second glabellar furrows. The posterior branches of the third glabellar furrows are longer (*exsag.*), and appear to end opposite the middle of the third glabellar lobes but, as the latter are partly crushed, this feature cannot be properly examined. The glabellar lobes

are thus connected to the median glabellar lobe by constricted, neck-like structures which, as far as can be seen, are slightly depressed dorsally, though there is no development of definite furrows. The axial furrows are narrow, uniformly deep, almost parallel frontally as far as the second glabellar furrows ; they then diverge slightly as far as the third glabellar furrows, beyond which they diverge more strongly, curving round the abaxial margins of the basal glabellar lobes to intersect the occipital furrow. The anterior border is conspicuously short (*sag.*), one-seventh of the median length of the glabella, becoming even shorter abaxially, beyond the axial furrows ; the anterior margin is transversely straight, as is the posterior margin opposite the frontal glabellar lobe, though there is a slight lengthening (*exsag.*) opposite the axial furrows. The flattened upper surface of the anterior border is inclined forwards at only a small angle to the dorsal surface of the glabella, that is to say, it would be approximately horizontal when the cranidium was in its, presumably, normal position. The anterior border and frontal glabellar lobe are separated by a deep, narrow (*sag.*), transversely straight furrow which curves slightly forwards abaxially beyond the axial furrows to separate the anterior border from the fixigenae. The occipital ring is relatively long (*sag.*), in length about one-sixth that of the glabella, parallel-sided medially, but shortening (*exsag.*) abaxially to accommodate the projecting posterior margins of the basal glabellar lobes, and forming a pair of poorly-defined occipital lobes. The occipital furrow is both shallow and transversely straight medially, but deepens distally, becoming convex backwards around the basal glabellar lobes. The pleuroccipital furrow, posterolateral portions of the fixigenae and the posterior branches of the facial suture, are not preserved. The palpebral lobes are of moderate size, inclined gently towards the lateral margins, and extending from opposite the second glabellar furrows to opposite the third glabellar furrows. The fixigenae are strongly convex both transversely and longitudinally, standing highest opposite the second glabellar lobes. They are parallel-sided frontally, the anterior branches of the facial suture running straight forwards from the eyes, and there is a pair of poorly defined eye-ridges extending slightly forwards adaxially from the anterior ends of the palpebral lobes and ending at the axial furrows opposite the first glabellar lobes. The surface of the test, excluding the furrows, all of which are smooth, is covered with fine, closely-set granules, generally of uniform size ; slightly larger granules occur sporadically, and uncommonly, over the surface of the glabella and fixigenae, becoming more common on the anterior border.

The hypostoma, thorax and pygidium are not known.

Horizon and locality. The only known specimen is from the Onnian Stage, *Onnia gracilis* Zone, in the north bank of the River Onny, 100 yards east of its junction with Batch Gutter.

Holotype. BM. In. 50653 (Pl. 39, fig. 6).

Discussion. This rare form is distinctive, and may easily be separated from all other known species of the genus, for example *G. praecox*, by the unusually short (*sag.*), straight anterior border, and by the large, inflated fixigenae, which are much broader than those of other forms. In addition, the palpebral lobes are situated farther forwards than those of *G. praecox*.

Family ASAPHIDAE Burmeister, 1843

Subfamily ASAPHINAE Burmeister, 1843

Recently *Parabasilicus* was placed by Jaanusson (*in* Moore, 1959 : 342) in the subfamily Isotelinae, whilst *Basilicus* was assigned to the Asaphinae. The affinities of *Parabasilicus* appear to lie with *Basilicus* rather than with the other genera of the Isotelinae, and accordingly the genus is here transferred to the Asaphinae.

Genus ***PARABASILICUS*** Kobayashi, 1934

TYPE SPECIES. *Parabasilicus typicalis* by original designation of Kobayashi (1934 : 475).

Parabasilicus powisi (Murchison)

(Pl. 40, figs. 1, 3–5 ; Pl. 41, figs. 1, 2 ; Pl. 42, fig. 9)

1839. *Asaphus powisi* Murchison, p. 661, pl. 23, fig. 9c only.
1851. *Isotelus* (*Basilicus*) *Powisii* (Murchison) M'Coy *in* Sedgwick & M'Coy, p. 170.
1866. *Asaphus* (*Basilicus*) *powisi* Murchison : Salter, p. 154, pl. 23, figs. 3–7.
1931. *Asaphus powisi* Murchison : Reed, p. 443.
1934. *Parabasilicius powisi* (Murchison) Kobayashi, p. 476.
1935. *Asaphus* (*Parabasilicus*) *powisi* Murchison : Reed, p. 13.
1937. *Parabasilicus powisi* (Murchison) : Kobayashi, p. 503.
1938. *Asaphus* (*Parabasilicus*) *powisi* Murchison : Stubblefield *in* Pocock *et al.*, pp. 89, 255.
1958. *Parabasilicus powisi* (Murchison) : Dean p. 220.
1961. *Parabasilicus powisi* (Murchison) : Dean & Dineley, p. 374, pl. 20, fig. 8.

DESCRIPTION. The species was described first by Murchison (1839 : 661) on the basis of two syntypes. One of these (Murchison, 1839, pl. 23, figs. 9*a*, *b*) has been shown to be a cephalon of *Chasmops extensa* (Boeck) and the other syntype (Murchison, 1839, pl. 23, fig. 9*c*) has been chosen as lectotype (Dean & Dineley, 1961 : 374). The latter specimen is a flattened, large pygidium with six attached thoracic segments, preserved as an external mould and refigured here as a vinyl plastic cast (Pl. 41, fig. 2). The pygidium is large, with frontal breadth 85 mm. and median length 52 mm., though it has been both vertically compressed and slightly sheared sinistrally. The anterior margin is gently convex forwards, whilst the remainder of the outline is broadly subparabolic. The axis is triangular in plan, though this has undoubtedly been exaggerated by crushing, bounded laterally by poorly-defined, straight, axial furrows which are hardly more than broad, shallow depressions. Frontally the axis occupies roughly one-third of the total glabellar breadth, and its anterior third carries traces of three large axial rings : beyond these the axis is virtually smooth, and ends in a slightly better-defined terminal piece, separated from the margin by a long (*sag.*) posterior border. The pleural lobes also have a broad, gently concave, smooth border, inside which the pleural fields are slightly convex dorsally with seven pairs of shallow, poorly-defined pleural furrows becoming progressively fainter posteriorly, the furrowed area extending only for about two-thirds of the length of the axis. Each pleural lobe has a large, steeply downturned, anterolateral facet ; on the lectotype, only the left facet is preserved, slightly distorted by crushing.

The thorax of the lectotype retains only six thoracic segments. Each axial ring is relatively long (*sag.*), transversely straight as far as the poorly-defined axial furrows. What appears, superficially, to be another pair of longitudinal furrows is found on the lectotype (Pl. 41, fig. 2), extending along the thorax and intersecting each axial ring at the points where it is curved backwards. This inner pair of " furrows " is not present on uncrushed specimens assigned to the species, although it is known from individuals which have undergone distortion, and is believed to be of tectonic origin. The thoracic pleurae are directed only slightly backwards distally, and end in blunt tips ; the latter are not preserved on the lectotype, but on other specimens each can be seen to form a small, spine-like posterolateral process which, presumably, functioned as a stop during enrollment. There is a well-defined pleural furrow on each pleura, running from the anterior margin at the axial furrow towards, but not reaching, the posterolateral part of the pleural tip. Immediately in front of this furrow is a parallel ridge which reaches the tip, though in a diminished form, and beyond the ridge the anterior band of the pleura is turned down anterolaterally, again a feature which was probably functional in enrollment.

No topotype cephalon is yet available, and the following description is founded on a cranidium from Pontesford, east Shropshire, which retains the full asaphid complement of eight thoracic segments, and has one associated librigena (Pl. 41, fig. 1). This individual shows the cranidium to be of depressed form, only gently convex both longitudinally and transversely, with straight posterior margin. The glabella is longer than broad in the ratio 4 : 3 and, although the frontal glabellar lobe is moderately well defined anteriorly but with no incised preglabellar furrow, the remainder of the glabella is poorly defined, particularly posteriorly, where it is continuous with the fixigenae and occipital ring. There are no glabellar furrows and the axial furrows are practically obsolete, apart from poorly defined depressions delimiting the lateral margins of the frontal glabellar lobe. The anterior border forms a brim-like structure, its anterior margin moderately convex forwards and its dorsal surface smooth, flattened or slightly concave. The palpebral lobes are strongly curved, placed opposite the middle of the glabella, their dorsal surface flat and continuous with that of the glabella. The anterior branches of the facial suture diverge forwards from the eyes for about half their length, but then curve strongly and evenly inwards to cut the anterior border at an acute angle, longitudinally in-line with the palpebral lobes. The posterior branches are moderately curved backwards from the eyes, and cut the posterior margin of the cephalon midway between the axial furrows and the lateral margins. One displaced librigena has been found in association with the cranidium (Pl. 41, fig. 1), though the visual surface of the eye is too badly damaged for examination. There is a broad, flat platform circumscribing the eye, and from this the remaining dorsal surface of the librigena declines gently to the margin, which is slightly concave, though there is no marginal furrow. The librigena is produced posterolaterally to form a stout, sharp, librigenal spine which extended originally as far as the mid-point of the thorax. None of the available specimens shows any ornamentation of the surface of the test, with the exception of the distal portions of the thoracic pleurae which carry terrace-lines between the pleural tips and the fulcrum. There is no trace of a median tubercle on the glabella,

though the exoskeleton has always been found damaged at the point where such a tubercle might be expected to occur.

No hypostoma has yet been recorded from the type-locality, nor has one been found in association with undoubted specimens of *Parabasilicus powisi*. However, a specimen, assigned doubtfully to the species, is figured here from the middle Costonian of the Coston district (Pl. 40, fig. 2). It is preserved as an internal mould, lacks the anterior wings, and is longer than broad in the ratio 6 : 5. The median body is gently convex both longitudinally and transversely, sub-ovate in plan, longer than broad, with a pair of well-defined maculae sited posteriorly, a short distance either side of the axial line. The posterior border is indented by a deep, parabolic notch which extends forwards as far as the median body and is flanked posterolaterally by a pair of broad points. From these points the flattened lateral border runs forwards in a curve, at first expanding and then contracting to meet the sides of the median body just in front of centre.

Lectotype. GSM. 6841 (Pl. 41, fig. 2).

Horizons and localities. The lectotype of *Parabasilicus powisi* was obtained from Trilobite Dingle (= Bron-y-Buckley Wood), Welshpool, and is therefore almost certainly of Harnagian age ; this tends to be confirmed by the state of preservation, which resembles that of the so-called Trilobite Dingle Shales. In south Shropshire, the earliest example of the species is from the Costonian Stage of the Evenwood district (Pl. 40, fig. 1) ; this is a smaller specimen than the lectotype, but shows all the specific characters, as far as can be judged, and closely resembles a specimen figured by Salter (1866, pl. 23, fig. 5) from an unspecified horizon at Waterloo Bridge, Conway. Asaphid remains are uncommon in the Harnagian strata of south Shropshire, but a fragmentary cranidium (Pl. 42, fig. 9) and pygidium, B.M. In. 55371, from the *Reuscholithus reuschi* Zone of Smeathen Wood, Horderley, can probably be assigned to *P. powisi*, as also can a relatively small cranidium and pygidium from the same horizon at Coundmoor Brook, Harnage (Pl. 40, figs. 4, 5).

The species *Asaphus* (*Basilicus*) *marstoni* was founded by Salter (1866 : 156, pl. 23, figs. 1*a*, *b*) on a small damaged dorsal shield preserved as an internal mould, together with the damaged right librigena of a slightly larger specimen, both from the " Shales of Horderly ". The syntypes are refigured here (Pl. 42, figs. 1, 6, 8). Although Reed (1931 : 470) claimed that the species was better referred to the genus *Proetus*, there can be little doubt that it is, as Salter believed, an asaphid. Reed's assertion that the specimen represents an immature individual with less than the usual proetid quota of thoracic segments seems to be incorrect, as the eight segments present are typically asaphid in both form and number. The cephalon is damaged but shows nevertheless a general resemblance to that of *Parabasilicus powisi*, as do the pleural lobes of the thorax, though the thoracic axis is more convergent posteriorly than that of the latter species. The pygidium resembles that of *P. powisi* in outline but the axis is better defined and the pleural fields of the pleural lobes are more strongly convex, with at least six pairs of moderately defined pleural furrows, though the number of both these, and the axial rings, present is obscured by abrasion and crushing. In the absence of additional material it seems advisable, for the present, to restrict the name *Parabasilicus* ? *marstoni* to the type-

specimens. The preservation of the type-material matches that of the Smeathen Wood Beds, belonging to the Harnagian Stage, of the Onny Valley near Horderley. The only other asaphids known from these strata are probably referable to *Parabasilicus powisi*, and *P.*? *marstoni* may well prove to be a synonym of the former species. The apparent differences could well be explained by variations in preservation or in the stage of development, and the more distinct furrowing of the pygidium of *P.*? *marstoni* may have disappeared by the time the adult stage was attained.

Evidence of *P. powisi* from the Lower Soudleyan, *Broeggerolithus broeggeri* Zone, is scanty, but includes a large pygidium and thorax from Glenburrell Farm (Pl. 40, fig. 3) as well as the cephalon and thorax already described from Habberley Brook, Pontesford. In the succeeding Upper Soudleyan and Lower Longvillian strata, asaphid fragments, especially pygidia, are not uncommon. The pygidium and hypostoma from " Horderley ", figured by Salter (1866, pl. 23, figs. 4, 6) as *Asaphus* (*Basilicus*) *Powisi*, are probably from the Horderley Sandstone. The hypostoma, now refigured (Pl. 42, fig. 2), is proportionately narrower than the Costonian specimen questionably referred here to *P. powisi* (Pl. 40, fig. 2), though bearing a general resemblance to the latter. None of the pygidia from these younger horizons may be satisfactorily matched with that of *P. Powisi*, and they (Pl. 40, fig. 6 ; Pl. 42, fig. 5), together with the hypostoma mentioned, are merely referred, with some uncertainty, to *Parabasilicus*. In general, the Longvillian pygidia, as well as being of slightly different outline, tend to exhibit more ring and pleural furrows than *P. powisi* ; in this respect they resemble the pygidium of *Parabasilicus* ? *marstoni*, already discussed, but until more satisfactory material becomes available specific identification is virtually impossible. The only evidence of asaphid trilobites from the Upper Longvillian of Shropshire is an unidentifiable fragment from the Alternata Limestone, and the family is unknown from all the succeeding strata.

The distribution of *Parabasilicus powisi* and allied forms in the south of Shropshire is of particular interest in that the genus is found most commonly elsewhere in the Chikunsan Beds of South Korea, from which area the type species was described by Kobayashi (1934 : 475). However, another asaphid genus, *Basilicus*, though best known from the Llandeilo Series of Wales, occurs also in Korea (Kobayashi, 1934 : 465). Elsewhere, trilobites assigned to *Parabasilicus* are recorded from both Bolivia and Virginia (Kobayashi, 1937 : 503 ; Raymond, 1925 : 85–86), though the former record has been questioned by Harrington and Leanza (1957 : 36), who tentatively report the genus from Argentina. Most of the Shropshire occurrences of *P. powisi* are in strata correlated with the *Diplograptus multidens* Zone, though known from the top of the preceding *Nemagraptus gracilis* Zone, and extending upwards at least a little way into the succeeding *Dicranograptus clingani* Zone. According to Kobayashi (1934 : 336) the Chikunsan Beds are of Llandeilo age, but as they contain *Diplograptus* (*Amplexograptus*) *perexcavatus* Lapworth, a species said to be common in the Llandeilo and early Caradoc Series of Great Britain (Elles & Wood, 1914 : 521), both they and the Korean species of *Parabasilicus* may be of an age comparable to those of Shropshire. The form most resembling *P. powisi*, as noted by Kobayashi (1934 : 480) is that described by him as *Parabasilicus shirakii* ; the differences between the two are small, the thoracic axis of *P. shirakii* being the

narrower, whilst the palpebral lobes are sited farther forwards than in *P. powisi*. Although several specific names were erected by Kobayashi for the material of *Parabasilicus* from Korea, it seems likely that only one or two species are, in fact, present, most of the apparent differences being the result of tectonic distortion or intraspecific variation.

The asaphid trilobite from the Richmond Formation of Ohio described by Foerste (1919 : 65, pls. 14, 14A, 15, especially 15) as *Isotelus brachycephalus* is a large form resembling *Parabasilicus* in some respects, including the anterior facial suture, the shape of the librigenae, the thorax, and the pygidial outline. However, the eyes are situated farther forwards, and the axial and pleural furrows of the pygidium are even less well defined than in the British species.

Family Illaenidae Hawle & Corda, 1847

Genus *ILLAENUS* Dalman, 1827

Type species. *Entomostracites crassicauda* Wahlenberg, 1821 by subsequent designation of Miller (1889 : 550).

Illaenus cf. *fallax* Holm

(Pl. 42, figs. 3, 4, 12)

1958. *Illaenus* sp., Dean, pp. 211–213, 224.

Several fragments of illaenid trilobites have been recovered from strata of Actonian and Onnian age in south Shropshire. They are often damaged and distorted, but a few of the best preserved are now figured. No undamaged cranidium has been found, and it has not proved possible to make a firm identification of most of those found (Pl. 42, figs. 7, 10, 11). Two pygidia, however, are undistorted and show certain distinctive features (Pl. 42, figs. 3, 4). The outline is well rounded, subparabolic, the median length about three-quarters of the maximum breadth, attained just behind the anterior margin. The axis, occupying about one-quarter of the frontal breadth, is triangular in outline, scarcely defined by faint axial furrows which converge backwards at 50 degrees to meet just in front of centre of the pygidium, and continue back as a single faint furrow for about half the distance to the posterior margin, finally being replaced by an extremely low, thin, median ridge which runs almost to the margin. The dorsal surface of the axis, which bears traces of four or five axial rings, is slightly depressed or level, whilst the surface of the pygidium outside the axial furrows is at first level and then declines fairly steeply towards the margins. The front of the axis is marked by a moderately deep, transversely straight, articulating furrow which turns backwards slightly as it crosses the axial furrows, and then becomes both deeper and markedly broader (*exsag.*), finally terminating at about the proximal margin of the doublure. Immediately in front of this furrow each pleural lobe carries a pronounced, broad (*exsag.*) ridge, bordered frontally by a large, steeply downturned, anterolateral facet.

Illaenus fallax was described by Holm (1882 : 82, pl. 2, figs. 11–20, pl. 5, figs. 15–24) using a number of syntypes stated to be from the " Chasmopskalk " of Sweden ;

several localities are mentioned in his account, and two or more horizons are almost certainly involved. One Shropshire cranidium (Pl. 42, fig. 12) is generally similar to that of *I. fallax*, whilst pygidia figured here bear a remarkably close resemblance to one figured by Holm (1882, Pl. 2, fig. 17) from Gulleråsen, a specimen which possesses also the characteristic axial outline, followed by a median groove and ridge. Thorslund (1940 : 140–141) recorded *Illaenus fallax* from different localities and horizons in Sweden, but he stated that the species occurs most abundantly in the Kullsberg Limestone of Dalecarlia, an horizon generally contemporaneous with those containing the Shropshire specimens.

Although *Illaenus fallax* has been supposed by Jaanusson (1954 : 574) to belong to what he calls the " *Parillaenus*-Gruppe " of *Illaenus s.s.*, some of the specimens which have been assigned to the species bear a certain resemblance to the genus *Stenopareia* Holm, 1886, and *Stenopareia camladica* has recently been described from the Soudleyan Stage of the Shelve Inlier by Whittard (1961 : 216, pl. 30, figs. 10–13).

Horizons and localities. Specimens of Actonian age have been found beside the River Onny, in the vicinity of the junction of the river with Batch Gutter ; at various exposures in and around the village of Acton Scott ; and at Gretton Quarry (now filled in), near Cardington. Localities in Onnian strata include the north bank of the River Onny about 63 yards east of its junction with Batch Gutter (*Onnia ? cobboldi* Zone) ; and the river bank 100 yards east of the same junction (*Onnia gracilis* Zone).

Family Lichidae Hawle & Corda, 1847

Subfamily Lichinae Hawle & Corda, 1847

Genus ***METOPOLICHAS*** Gürich, 1901

Type species. *Metopias huebneri* Eichwald, 1842 by subsequent designation of Reed (1902 : 62).

Metopolichas? sp.

(Pl. 43, figs. 3, 4, 6, 7)

1938. *Lichas* aff. *verrucosa* (Eichwald), Stubblefield *in* Pocock *et al.*, p. 255.
1958. *Metopolichas* ? aff. *verrucosa* (Eichwald) Dean, p. 218.

Two fragmentary cranidia from the Costonian Stage may tentatively be referred to *Metopoliches*. They are too incomplete to provide a detailed description of the species, but bear a general resemblance to *Metopolichas patriarchus* (Wyatt-Edgell), recently redescribed by Whittard (1961 : 194, pl. 25, figs. 14–17) from west Shropshire. As far as the state of preservation permits, the fragments differ from *M. patriarchus* in having a greater convexity, smaller basal lateral lobes, and straighter longitudinal furrows. Such differences may, however, be nothing more than the consequence of a different mode of preservation, and a full description of the south Shropshire form must await additional material. *M. patriarchus*, although originally described from the Llanvirn Series of Wales, has been found by Whittard in the

Llandeilo Series of the Shelve Inlier, an horizon not appreciably earlier than the Costonian Stage.

Horizon and localities. Zone of *Harknessella subquadrata*, Stevenshill Quarry, by the south-eastern side of the brook, 1,500 yards south-west of Harnage Farm, Harnage. Zone of *Costonia ultima*, the old quarry, now filled in, 650 yards west of Woolston House, Woolston. Both horizons constitute the highest subdivision of the Costonian Stage in, respectively, the northern and southern parts of the Caradoc district.

Subfamily Homolichinae Phleger, 1936

Genus ***PLATYLICHAS*** Gürich, 1901

Type species. *Lichas margaritifer* Nieszkowski, 1857 by original designation of Gürich (1901 : 522).

Platylichas laxatus (M'Coy)

(Pl. 43, figs. 1, 2, 5, 8–12)

1846. *Lichas laxatus* M'Coy, p. 51, pl. 4, fig. 9.
?1846. *Calymene* (?) *forcipata* M'Coy, p. 48, pl. 4, fig. 14 (Pygidium only).
1848. *Lichas laxatus* M'Coy : Salter *in* Phillips & Salter, p. 340, pl. 8, fig. 6.
1851. *Trochurus nodulosus* M'Coy *in* Sedgwick & M'Coy, p. 151, pl. 1, F, fig. 16.
1852. *Lichas nodulosus* (M'Coy) Salter, p. iv.
1854. *Lichas sexspinus* Angelin, p. 74, pl. 38, figs. 7–8*a*.
1854. *Lichas aculeatus* Angelin, p. 75, pl. 38, figs. 11, 11*a*.
1854. *Lichas laxatus* M'Coy : Murchison, p. 201, fig. 29, 5.
1859. *Lichas laxatus* M'Coy : Murchison, p. 223, fig. 44, 5.
1866. *Lichas laxatus* M'Coy : Salter, p. 324, pl. 19, figs. 1–3.
1866. *Lichas segmentatus* Linnarsson, p. 18, pl. 2, fig. 4.
1867. *Lichas laxatus* M'Coy : Murchison, p. 204, fig. 46, 5.
1872. *Lichas laxatus* M'Coy : Murchison, p. 204, fig. 46, 5.
1884. *Lichas laxatus* M'Coy : La Touche, pl. 3, fig. 63.
1885. *Lichas laxata* M'Coy : Schmidt, p. 125, pl. 6, fig. 24.
1906. *Lichas laxatus* M'Coy : Olin, p. 53, pl. 1, figs. 27, 28.
1908. *Lichas laxatus* M'Coy : Wiman, p. 133, pl. 8, fig. 23.
1937. *Platylichas laxatus* (M'Coy) : Phleger, p. 1090.
1938. *Platylichas laxatus* (M'Coy) *pars* : Stubblefield, p. 34.
1939. *Platylichas laxatus* (M'Coy) : Warburg, p. 118, pl. 12, figs. 1–4, 6, 7, 9–12.
1945. *Platylichas laxatus* (M'Coy) : Størmer, p. 417, pl. 4, fig. 15.
1945. *Platylichas laxatus* (M'Coy) : Bancroft, p. 183.
1958. *Platylichas laxatus* (M'Coy) : Dean, p. 224.
1958. *Platylichas laxatus* (M'Coy) : Tripp, p. 579, pl. 85, figs. 3–5.

This oft-quoted Ordovician trilobite species was founded on a single, incomplete, slightly compressed cranidium, preserved in a dark-grey, shaly mudstone. The specimen is in the M'Coy Collection at the National Museum of Ireland, and is refigured here for the first time since M'Coy's original publication (Pl. 43, fig. 10). The outline of the central glabellar lobe is clavate, narrowing posteriorly to a minimum breadth opposite the posterior portions of the bicomposite lateral lobes, which themselves converge backwards at roughly 70 degrees. The central glabellar lobe expands both frontally, constituting the maximum length of the glabella, and

transversely, so that it is level with the distal margins of the bicomposite lateral lobes. The short (*sag.*), flattened, anterior border forms a rim which is separated from the central lobe by a shallow, narrow (*sag.*) furrow containing a pair of hypostomal pits opposite the intersection of the axial and longitudinal furrows. The right palpebral lobe is almost completely preserved; its length is half that of the bicomposite lateral lobe, and carries a conspicuous palpebral furrow. The longitudinal furrows are moderately deep, curved, converging backwards for most of their length, and then diverge to circumscribe the bicomposite lateral lobes. At this point the holotype is broken, but Tripp (1958, pl. 85, fig. 4) has figured a more complete topotype cranidium showing most of the essential features.

Platylichas laxatus was described in considerable detail by Warburg (1939 : 118) on the basis of Norwegian and Swedish material, which she considered to be specifically identical with that from Ireland. There can be no doubt that, at least as far as the cranidium of *P. laxatus* is concerned, there are no significant differences between Irish, Welsh, English and Scandinavian specimens. The pygidium and hypostoma of the south Shropshire and Scandinavian forms are, for all practical purposes, identical but the hypostoma, thorax and pygidium of *P. laxatus* have not yet been described from topotype material. Until this has been done, it seems preferable to follow Warburg's interpretation of the species, though it may eventually prove necessary to recognize several different species or subspecies.

Under the name *Calymene forcipata*, M'Coy (1846, pl. 40, fig. 14) figured from the "Silurian" of "Slieveroe, Rathdrum", Ireland, a cranidium and pygidium, of which the latter has been generally supposed to represent *Platylichas laxatus*. In order to stabilize the nomenclature of *Calymene forcipata*, the cranidium figured by M'Coy, now housed in the National Museum of Ireland, is here chosen as lectotype, and may be referred to the genus *Flexicalymene*. The pygidium figured by M'Coy is refigured in the present paper (Pl. 43, fig. 9). The specimen is unusually long, but this is due in part to mechanical deformation. Excluding the pleural spines, of which only the third pair is preserved intact, the outline is roughly semi-elliptical. The axis occupies about one-third of the total breadth, and half the length of the pygidium; it is mainly parallel-sided, but posteriorly becomes tapered and increasingly convex, whilst the terminal piece is poorly defined. Frontally the axial furrows are well defined and almost parallel, but become convergent near the terminal piece of the axis; beyond the latter they diverge slightly and terminate at the inner margin of the doublure, about halfway to the posterior margin. The axis has two well-defined axial rings with traces of an additional two. The pleural lobes carry three pairs of pleurae, each of which has a pair of well-defined pleural furrows and terminates laterally in a pair of backwardly-directed pleural spines, though the last-named are only partly preserved. It seems advisable to refer this specimen merely to *Platylichas* sp. until further material is available from the original locality.

Holotype. M'Coy Collection, National Museum of Ireland (Pl. 43, fig. 10).

Horizon and localities. *Platichas laxatus* has been found at several localities in south Shropshire, almost all of them comprising strata of the Actonian Stage. They include the bed and banks of the River Onny immediately east and west of

its junction with Batch Gutter; the section in the upper part of Batch Gutter itself; several points in and around the village of Acton Scott; exposures near Plaish, north-east of Church Stretton; and Gretton Quarry (now filled in), north-east of Cardington. The species has not been found higher than the *Onnia ? cobboldi* Zone of the Onnian Stage in Shropshire, at which horizon it occurs at the exposure in the north bank of the Onny, 63 yards east-south-east of its junction with Batch Gutter. Outside Shropshire, *P.* cf. *laxatus* has been recorded from the Pusgillian Stage and highest Onnian of the Cross Fell Inlier.

Family Odontopleuridae Burmeister, 1843

Subfamily Odontopleurinae Burmeister, 1843

Genus ***PRIMASPIS*** R. & E. Richter, 1917

Type species. *Acidaspis primordialis* Barrande, 1852 by original designation of R. & E. Richter (1917 : 466).

Primaspis harnagensis (Bancroft)

(Pl. 44, figs. 1, 4, 6, 8)

1949. *Acidaspis harnagensis* Bancroft, p. 301, pl. 10, figs. 21, 22.
1958. *Primaspis harnagensis* (Bancroft) Dean, p. 201.
1962. *Primaspis harnagensis* (Bancroft) : Dean, p. 122.

Description. The exoskeleton is known only from a few disarticulated cranidia, together with a single, detached librigena and pygidium. The glabella is subparabolic in plan, strongly convex, its upper surface declined frontally, with median length slightly greater than the maximum breadth, measured across the basal glabellar lobes. The frontal glabellar lobe is small, less than one-fifth of the length of the glabella, and bluntly pointed. There are three pairs of glabellar lobes, those of the third pair being the largest, almost oval in plan, slightly divergent forwards, and just over one-third the length of the glabella. The second glabellar lobes are subcircular in plan, about half the size of the third lobes. Both pairs of lobes are defined by deep second and third glabellar furrows which run backwards, and apparently continue, though shallower, so as to circumscribe the second and third lobes. This last feature is known only from internal moulds preserved in mudstones or shales, and may have been exaggerated by crushing. First glabellar lobes are represented by small, tubercle-like projections, delimited frontally by shallow, straight, first glabellar furrows directed only slightly backwards. The axial furrows are curved, strongly convex abaxially, shallowest just behind the line of the second glabellar furrows and then deepening both anteriorly and posteriorly. The anterior border, though incompletely known, is apparently of typical odontopleurid type, narrowest (*sag.*) medially but broadening abaxially, and delimited posteriorly by a poorly-defined furrow. The occipital ring is strongly convex transversely, with straight upper surface; it is longest (*sag.*) medially, almost one-quarter the length of the glabella, but shortens markedly abaxially, at the same time turning sharply forwards anterolaterally to form a pair of distinct occipital lobes. The glabella and occipital

ring are separated by a straight, broad (*sag.*), occipital furrow which deepens distally. The fixigenae are strongly convex, standing highest posteriorly, where they are slightly narrower than the basal glabellar lobes, and decline steeply forwards to end opposite the first glabellar lobes. The palpebral lobes, though poorly known, are apparently strongly convex abaxially, with well-defined palpebral furrows and palpebral rims which are continued forwards as eye ridges to join the frontal glabellar lobe. The ocular surface of the eyes is not known. The anterior branches of the facial suture are convergent forwards, and apparently cut the cephalic margin opposite the anterior ends of the axial furrows, though this part of the exoskeleton has not been found well preserved. As far as can be judged from the available material, the posterior branches run from the palpebral lobes, a little in front of the pleuroccipital furrow, backwards to cut the posterior border at the base of the librigenal spines. The single available librigena (Pl. 44, fig. 8) is of typical odontopleurid form, steeply declined distally from the eye towards the raised marginal rim, the latter defined proximally by a deep marginal furrow which ends at the pleuroccipital furrow. The marginal rim is continued posterolaterally to form a librigenal spine, the length of which is at least equal to that of the remainder of the librigena. There are at least thirteen, slender, marginal spines, transversely straight or directed slightly backwards, and increasing in length (*tr.*) towards the genal angle.

The hypostoma and thorax are not known.

The pygidium, excluding marginal spines, is transversely semielliptical in plan, between three and four times as broad (*tr.*) as long. The axis, occupying frontally one-quarter of the maximum breadth, narrows backwards slightly at first, but ends in a small, bluntly pointed terminal piece which reaches the margin. There are three axial rings, the first well defined, the second and third less so. The axial furrows are moderately deep except frontally, where the first axial ring is produced posterolaterally as a pair of strong raised ridges which cross the flat pleural regions and continue beyond the posterior margin as the fifth and largest of seven pairs of spines distributed evenly along the margin. The first four pairs of spines increase in size from small to only slightly shorter than the conspicuous, stout, fifth pair. The sixth and seventh pairs are slender and subparallel backwards.

The surface of the cephalon, excluding most of the furrows, is covered with closely-set granules of small, almost uniform, size. Similar granules ornament the entire dorsal surface of the librigena, including the librigenal spine, but the marginal spines are smooth. The axis and pleural lobes of the pygidium are covered with slightly coarser granules, but the furrows and pleural spines are apparently smooth.

Lectotype, here chosen. BM. In. 42086.

Paratype. BM. In. 42087 (Pl. 44, fig. 6).

Horizon and localities. The type-locality is the Smeathen Wood Beds, Harnagian Stage, *Reuscholithus reuschi* Zone, at the cart-way section near the southern end of Smeathen Wood, Horderley. A single cranidium has also been collected from the same horizon in the north bank of Coundmoor Brook, 1,300 yards south-west of Harnage Farm, Harnage.

Discussion. For convenience the discussion of *Primaspis harnagensis* is grouped with that of *P. caractaci*.

Primaspis caractaci (Salter)

(Pl. 44, figs. 3, 7, 9, 11, 13, 14)

1853. *Acidaspis caractaci* Salter, p. 7.
1857. *Acidaspis caractaci* Salter : Salter, p. 211, pl. 6, figs. 15–17.
1949. *Acidaspis caractaci* Salter : Bancroft, p. 303.
1958. *Primaspis caractaci* (Salter) Dean, pp. 211, 223, 224.
1962. *Primaspis caractaci* (Salter) : Dean, p. 122.

Description. The dorsal exoskeleton, excluding pleural and pygidial spines, is roughly oval in plan, longer than broad approximately in the ratio 3 : 2. The cephalon is transversely semielliptical in plan, more than twice as broad as long. The glabella is steeply declined forwards, almost as broad as long, attaining its maximum breadth just in front of the occipital furrow, whence it narrows markedly to the subparabolic frontal glabellar lobe. There are three pairs of glabellar lobes, those of the basal pair being suboval in plan, moderately divergent forwards, and of large size, about one-third of the glabellar length. The second glabellar lobes are just over half the length of the basal lobes and slightly oval in plan, with long axes parallel to those of the succeeding pair. First glabellar lobes, originally stated by Salter (1857 : 211) to be obsolete, are poorly represented by a pair of small tubercles, the sudden diminution in size between the second and first pair of lobes resulting in a break in the glabellar outline. The second and third glabellar furrows are parallel to one another, deep, bifurcating, and circumscribe the second and third glabellar lobes, which are thus separated from the almost parallel-sided central glabellar lobe. The axial furrows are narrow and curved, convex abaxially, deepening both frontally and posteriorly but becoming shallower medially, opposite the third glabellar furrows. The anterior border is narrow (*sag.*), moderately inclined forwards, broadening laterally, and separated from the glabella by a furrow which increases in depth abaxially. The occipital ring is relatively long (*sag.*), becoming shorter laterally where it forms two distinct occipital lobes and extends forwards to join with the fixigenae ; it is delimited frontally by a broad (*sag.*), transversely straight, occipital furrow which deepens laterally. Each librigena is quadrant-shaped, and its upper surface declines steeply from the eye to a moderately-deep marginal furrow which ends posterolaterally at its intersection with the pleuroccipital furrow. The lateral margin is thickened, ridge-like, produced posterolaterally at the genal angle to form a stout, librigenal spine, the length of which is at least equal to that of the cephalon. The lateral margin carries thirteen, or occasionally fourteen, short (*tr.*) border spines, the hindmost of them almost transversely straight, becoming progressively less divergent forwards.

The hypostoma is not known.

The thorax comprises ten segments. The axis is moderately convex transversely and the pleural lobes are flat as far as the bases of the pleural spines. Each pleura is divided into two bands by a pleural furrow which runs gently backwards distally from the anterior margin of the pleura at its junction with the axial furrow. The anterior pleural band is narrow (*exsag.*), moderately convex, the tip produced laterally into a short (*tr.*) pleural spine. The posterior pleural band is broader (*exsag.*), more convex, ridge-like, produced posterolaterally to give a posterior

pleural spine of length almost equal to that (*tr.*) of the pleura itself. The posterior pleural spines become progressively more strongly directed backwards from front to rear of the thorax.

The pygidium, excluding marginal spines, is transversely semielliptical in plan, with straight anterior margin. The axis occupies about one-quarter of the maximum breadth of the pygidium, and its anterior portion is strongly convex dorsally ; the remainder of the axis declines posteriorly and fails to reach the margin, apparently ending in-line with the inner limit of the doublure. There is evidence of at least two axial rings. The first of these is produced, in the form of a pair of large raised ridges, posterolaterally to the margin, beyond which it continues as a pair of stout spines, slightly divergent backwards. In front of these large spines are situated two pairs of small, slender, parallel spines, whilst the posterior margin of the pygidium carries a further three pairs of small spines of similar size and form, parallel to one another and directed straight backwards.

One of the syntypes of *P. caractaci* (Pl. 44, fig. 13) shows the exoskeleton in what may have been the position of rest of the animal on the sea-floor. The occipital ring and pleuroccipital segment are in the same vertical plane, and in this posture the glabella is steeply declined forwards. At the same time the cephalic margins rest on the border spines of the librigenae, the progressive increase in length of the spines posterolaterally assisting in maintaining the position of the cephalon. The thorax is flexed downwards slightly at its midpoint, rising again towards the pygidium which is, in turn, turned down. A comparable condition is known from other groups of trilobites, for example, the Trinucleidae and Calymenidae, and may be posthumous.

The dorsal surface of the glabella, proximal parts of the librigenae, thorax and pygidium, excluding furrows, is mostly covered with coarse granules, the intervening space between the latter being ornamented with granules of smaller size. The glabellar furrows are smooth, but there is a tendency for the smaller granules to persist across the occipital furrow (Pl. 44, fig. 7). Both the lateral border furrow and the lateral border of the cephalon are finely granulate, the granulation extending over part of the border spines, as far as can be judged.

Horizons and localities. The earliest specimen of *Primaspis caractaci* known from south Shropshire is a single librigena from the *Onniella reuschi* Zone of the Marshbrookian Stage, just south of Marsh Wood Quarry, Marshbrook. The species becomes much more abundant, however, in the succeeding Actonian Stage, particularly in the more arenaceous facies, though it is rare in the grey mudstone succession of the Onny Valley. Localities include the stream section just south of the waterfall at the western end of Chuney Pool, Acton Scott ; the old quarry 210 yards east of Acton Scott Church ; the stream section by the east side of the road-bridge about 350 yards west-south-west of Hatton ; and the old quarry, now filled in, at Quarry Field, Cardington. The last-named locality yielded the type-specimens of *P. caractaci*, together with numerous other specimens of the species.

Syntypes. GSM. 5214 (Pl. 44, fig. 9) ; GSM. 35473 (Pl. 44, fig. 13).

Discussion. The cranidium is of generally similar form in both *Primaspis harnagensis* and *P. caractaci*, but the former species may be distinguished by its

shorter occipital ring, narrower glabella and, perhaps, longer basal glabellar lobes. The pygidia of these forms may be separated more easily, that of *P. harnagensis* having two posterior and four anterior pairs of small marginal spines in addition to the single large pair, whilst the pygidium of *P. caractaci* has three posterior and only two anterior pairs of small spines.

The only other species of *Primaspis* described from the Caradoc Series of the Anglo-Welsh area, *P. semievoluta* (Reed, 1910 : 214, pl. 17, figs. 1–3 ; Dean, 1962) from the Longvillian Stage of the Cross Fell Inlier, has a pygidium with two posterior and two anterior pairs of small marginal spines separated by a single pair of large spines. The pygidium is also slightly longer proportionately than that of the two Shropshire species.

The cranidium of *Primaspis ascitus* (Whittington, 1956 : 199, pls. 1, 2), from the Middle Ordovician of Virginia, is relatively broader than that of *P. harnagensis* and bears a remarkably close resemblance to that of *P. caractaci* though the anterior border of the last-named is slightly longer (*sag.*). The pygidium of *P. ascitus* is more easily distinguished and carries, in addition to the largest pair of margin spines, a further five pairs of small spines, three pairs situated anteriorly and the remaining two pairs posteriorly. An unusual feature common to the pygidia of *P. ascitus* and *P. caractaci* is the manner in which the basal part of each of the large pair of spines is expanded so as to merge with the proximal half of the first succeeding small, marginal spine (Pl. 44, fig. 9 ; see also Whittington, 1956, pl. 1, figs. 9, 10).

In a recent paper Whittard (1961 : 203, pl. 27, fig. 12 ; pl. 27, fig. 13) has figured what he calls *Primaspis* cf. *harnagensis* (Bancroft) and *P.* cf. *caractaci* (Salter) from the Spy Wood Grit of the Shelve district, an horizon approximately contemporaneous with the early Harnagian Stage of south Shropshire. The specimens are too fragmentary for certain indentification but appear to be distinct from either of the south Shropshire forms and may represent a new species.

Family Olenidae Burmeister, 1843

Subfamily Triarthrinae Ulrich, 1930

Genus ***TRIARTHRUS*** Green, 1832

Type species. *Triarthrus becki* Green, by monotypy (Green, 1832 : 86–87).

Triarthrus cf. ***linnarssoni*** Thorslund

(Pl. 44, figs. 2, 5, 10, 12)

1940. *Triarthrus linnarssoni* Thorslund, p. 128, pl. 12, figs. 4–12.
1945. *Triarthrus* sp., Bancroft, p. 183.
1949. *Triarthrus* sp. Bancroft, map on p. 302.
1958. *Triarthrus* sp., Dean, pp. 213, 225.
1960. *Triarthrus* cf. *linnarssoni* Thorslund : Dean, p. 86.

Three cranidia in varying degrees of completeness, and a single, small, incomplete pygidium, have been examined, all from one locality in south Shropshire. They

match the material described by Thorslund (1940 : 128) in both the shape and proportions of the cranidium and in the position of the palpebral lobes. Librigenae of the Shropshire form have not yet been discovered.

The pygidium (Pl. 44, fig. 2) has a broad axis occupying almost half the total breadth, though this proportion may have been exaggerated by crushing, and tapering backwards only slightly, its junction with the posterior margin being indistinct. There are two well-defined axial rings, with a third ring less well defined. The pleural lobes carry at least two, and possibly three, pleural furrows which extend from the axial furrows to the margin, the ribs so defined curving backwards strongly in the same direction. The pygidium of *T. linnarssoni* has not yet been described, and comparison is therefore impossible.

Horizon and locality. *Onnia* Beds, Onnian Stage, *Onnia superba* Zone, at the " Cliff Section " in the north bank of the River Onny, 720 yards west-south-west of Wistanstow Church.

Discussion. Thorslund's type-specimens came from Västergötland and Jemtland, Central Sweden, where the species occurs in both the Upper Chasmops beds and shales of the corresponding *Dicranograptus clingani* Zone. As has been pointed out elsewhere (Dean, 1960 : 85–86), the trilobite assemblage of these Swedish strata is closely comparable with that of the highest Ordovician rocks of the south Shropshire succession.

Family Otarionidae R. & E. Richter, 1926

Genus ***OTARION*** Zenker, 1833

Type species. *Otarion diffractum* Zenker, 1833 by subsequent designation of R. & E. Richter (1926 : 95).

Otarion sp.

(Pl. 45, fig. 1)

1958. *Otarion* sp., Dean, p. 223.

Trilobites which can be assigned broadly to this genus are uncommon in south Shropshire. A few specimens have been found in the middle and upper Marshbrookian and in the Actonian, one of the best preserved, an incomplete cranidium about 2·5 mm. long, being figured here. The glabella is subparabolic in outline, occupies just over two-thirds of the median length, and is strongly inflated, particularly frontally. There is one pair of basal glabellar lobes, in length about two-fifths that of the glabella, from which they are separated by a pair of deep, curved, basal glabellar furrows. The preglabellar field is convex, steeply declined frontally, separated by a broad (*sag.*), well-defined, anterior border furrow from the thick, slightly flattened, anterior border. Both preglabellar field and anterior border are of equal breadth (*sag.*). The fixigenae are only partly preserved but apparently stand highest opposite the anterior part of the basal glabellar lobes, and are declined frontally, where they are continuous with the preglabellar field. The occipital ring, delimited anteriorly by a deep, transversely straight, occipital furrow, is strongly convex transversely, becoming thicker medially where it is directed upwards and slightly backwards.

The surface of the glabella, fixigenae and preglabellar field, excluding the furrows, which are smooth, is covered with conspicuous, coarse tubercles, but that of the anterior border is finely granulate.

Horizons and localities. Specimens belonging, apparently, to the same species have been found in the Marshbrookian Stage both at and near Marsh Wood Quarry, Marshbrook ; in the stream-section 550 yards south-south-west of Common Farm, Wallsbank ; and by the track 2,900 feet north-west of the Methodist Chapel, Cardington. The highest record is from the middle Actonian at the old quarry 210 yards east of St. Margaret's Church, Acton Scott.

Family Proetidae Burmeister, 1843
Subfamily Proetidellinae Hupé, 1953
Genus ***PROETIDELLA*** Bancroft, 1949

? *Ogmocnemis* Kielan, 1959.

Type species. *Proetidella fearnsidesi* by original designation of Bancroft (1949 : 304).

Proetidella fearnsidesi Bancroft

(Pl. 45, figs. 3–8, 12, 14)

1949. *Proetidella fearnsidesi* Bancroft, p. 304, pl. 10, fig. 23.
1953. *Decoroproetus fearnsidesi* (Bancroft) Přibyl, p. 60.
1958. *Decoroproetus fearnsidesi* (Bancroft) : Dean, pp. 201, 219.
?1961. *Ogmocnemis calvus* Whittard, p. 186, pl. 24, fig. 15.
1962. *Proetidella fearnsidesi* Bancroft : Dean, p. 126.

Description. The dorsal exoskeleton of the holotype, the most complete specimen known, is oval in plan, longer than broad in the ratio 9 : 7. The roughly semicircular cephalon occupies one-third the median length of the holotype, with the glabella equal to one-third the cephalic breadth. The holotype is a flattened specimen, preserved in shaly mudstone, and its appearance and proportions are consequently distorted, but in the case of a specimen preserved in sandy limestones of late Costonian age (Pl. 45, figs. 6, 7) the cephalon is convex both longitudinally and transversely, with the glabella occupying half the cephalic breadth. The glabella of the holotype, including occipital ring, is as long as broad ; however, the specimen is not only compressed but damaged, and its apparently irregular outline, narrowing forwards to a blunt point, is misleading, though it has been illustrated by Struve (*in* Moore, 1959 ; fig. 301, 1). The uncrushed glabellar outline is subparabolic, well rounded frontally, and occasionally the anterior half is slightly constricted. Flattened topotype cranidia tend to appear broader, though with the same general outline, and there is some variation in the ratio of length to breadth (Pl. 45, figs. 12, 14). Most of the known cranidia have no glabellar furrows, though one or two bear traces of a basal pair ; the conspicuous basal furrows shown in Struve's illustration (*in* Moore, 1959, fig. 301, 1) are the result of crushing. The glabella is circumscribed laterally and frontally by a narrow, moderately-deep furrow representing the conjoined axial and preglabellar furrows. The glabella is preceded by a preglabellar

field and anterior border of somewhat variable form. The preglabellar field is flat, varying in length from one-sixth to one-eighth that of the glabella. The line of demarcation between preglabellar field and anterior border is generally poorly defined in topotype material, with no distinct anterior border furrow (Pl. 45, figs. 3, 12, 14), but specimens in a more arenaceous matrix (see, for example, Pl. 45, fig. 5) tend to have a better defined, more steeply upturned, anterior border. The occipital furrow is well defined and moderately deep, flexing forwards a little both medially and laterally. The occipital ring follows a similar course, ending laterally in poorly defined occipital lobes ; its median length is about one-fifth that of the glabella, and in certain rare instances (Pl. 45, fig. 14) there is a small median tubercle. The eyes, the visual surface of which is not known, are elongated, semielliptical in plan, and slightly convergent forwards, equal in length to just over half that of the glabella. They are each delimited laterally by a moderately defined eye platform, and extend forwards from points sited just outside the axial furrows and opposite the occipital furrow. The combined palpebral lobes and fixigenae are thus small and narrow, becoming almost obsolete both anteriorly, immediately in front of the eyes, and posteriorly, where they reach a minimum opposite the pleuroccipital furrow and then expand suddenly to form part of the pleuroccipital segment (Pl. 45, fig. 4). The anterior branches of the facial suture extend only a very short distance forwards from the eyes, parallel to the axial furrows, before becoming suddenly and markedly divergent almost as far as the anterolateral margin where they turn adaxially through a right-angle and cut the margin at points longitudinally in line with the hindmost parts of the axial furrows. The posterior branches run backwards from the eyes, just outside and parallel to the axial furrows, as far as the pleuroccipital furrows ; there they change direction suddenly, running straight outwards and back to cut the posterior margin of the cephalon at points about mid-way between the axial furrows and the lateral margins. The librigenae thus formed are of relatively large size, produced posterolaterally to form long, broad-based librigenal spines, the points of which end in-line with the mid-point of the thorax, between the fifth and sixth thoracic segments.

The hypostoma is unknown.

The thorax of the flattened holotype comprises ten segments, and is divided into three longitudinal lobes of approximately equal breadth by narrow, deep, axial furrows which are parallel from the first to fifth axial rings, beyond which they converge backwards until the breadth (*tr.*) of the tenth axial ring is little more than half that of the first. The axial rings are of the same general shape as the occipital ring, though perhaps a little shorter (*sag.*). The pleurae are transversely straight for the most part, but beyond the fulcra become directed backwards and end in short pleural spines. Each pleura is divided into two bands of unequal breadth (*exsag.*), of which the anterior band is the narrower, by a sharply defined pleural furrow ; each pleural furrow runs slightly backwards distally from the axial furrow, but turns backwards sharply at the fulcrum towards the pleural spine, at the same time becoming markedly shallower.

The pygidium is broadly subparabolic in plan with margin entire, the breadth about two-and-a-half times the median length in the case of the holotype. The

tapering axis occupies just over three-quarters of the median length, carries six well-defined axial rings, and ends in a terminal piece of moderate length, with a small postaxial ridge extending to the margin. The doublure is of even breadth, extending inwards from the posterior margin as far as the tip of the axis. Each side-lobe carries four deeply impressed pleural furrows which curve backwards evenly to intersect the lateral margins ; there are, in addition, one or two further pairs of only poorly defined pleural furrows. The pleural ribs so formed carry faintly impressed rib furrows which are not parallel to the pleural furrows, but run backwards only slightly for about three-quarters of their length and then turn sharply back to the margin. Each rib is thus divided into two bands, of which the anterior is the narrower (*exsag.*).

Excluding all furrows the entire dorsal surface of the exoskeleton is ornamented with a series of thin, raised, anastomosing ridges so as to form a Bertillon pattern which is particularly conspicuous on the glabella.

Horizons and localities. The holotype is from shaly mudstones of the basal Harnagian, *Reuscholithus reuschi* Zone, in the old cartway near the south end of Smeathen Wood, Horderley, and a few other specimens have been recovered from this locality. *Proetidella fearnsidesi* occurs also, and in small numbers, at the same horizon as exposed 550 yards north-west of Woolston House, Woolston. In the northern part of the Ordovician outcrop in south Shropshire the same species may be found occasionally in the topmost subdivision, the *Harknessella subquadrata* Beds, of the Costonian Stage.

Holotype. BM. In. 42083 (Pl. 45, fig. 3).

Discussion. It has recently been suggested by Dean (1962) that *Ogmocnemis calvus*, described by Whittard (1961 : 186) from the Lower Soudleyan of the Shelve Inlier, may prove to be synonymous with *P. fearnsidesi*. *O. calvus* was founded on a single specimen, so there is no information concerning variation within the species. The preglabellar field and anterior border are apparently fairly well differentiated, but this may not be of specific significance, particularly in view of the variation in Harnagian specimens of *P. fearnsidesi*, and the two species are regarded here as being probably synonymous. Specimens of *Proetidella* are figured in the present paper from the Upper and, probably, Lower Soudleyan of south Shropshire (Pl. 45, figs. 9–11). They show small differences from *P. fearnsidesi* in glabellar outline and degree of differentiation of the anterior border, but owing to lack of material it has been impossible to demonstrate whether or not these are more than an expression of a different environment and lithology. The specimens, which are closely similar to the holotype of *Ogmocnemis calvus*, are therefore only compared with *P. fearnsidesi*.

There are in the old collections of the Geological Survey & Museum certain specimens, numbered 35614–35616 and 35618–35620, which are labelled *Proetus ovatus*, a manuscript name attributed to Salter. The specimens are typical *Proetidella fearnsidesi*, and the state of preservation suggests that they originated from the Smeathen Wood Beds of the Horderley district.

The Norwegian species *Proetus asellus* (Esmark), from metamorphosed shales of probable Llanvirn age, has been redescribed and figured by Størmer (1940 : 122,

pl. 1, fig. 1). The glabella is of more uniform breadth than that of *Proetidella fearnsidesi*, and the anterior border is apparently better differentiated from the long (*sag.*) preglabellar field, though the importance of the latter feature may not be great. However, the general resemblance of the two forms is enough to suggest that *Proetidella*-like trilobites existed earlier than the Caradoc Series, though the group is inadequately known.

Proetidella? sp.

(Pl. 45, fig. 13)

1958. *Proetus* (*s.l.*) sp., Dean, p. 223.

A single proetid cranidium has been recovered from the Upper Cheney Longville Flags, west of the village of Hatton. The glabellar outline is relatively broad, especially posteriorly, becoming broadly convergent frontally towards the well-rounded frontal glabellar lobe after constricting noticeably at about its mid-point. There is a suggestion of a pair of basal glabellar furrows, but as the specimen is somewhat damaged this feature may have been exaggerated by crushing. The anterior border is bluntly pointed medially, gently inclined forwards, separated from the broad (*sag.*), preglabellar field by a shallow, anterior border furrow. The glabella is circumscribed by a conspicuous preglabellar furrow, continuous laterally with deep axial furrows which become shallower medially. Part of the right occipital lobe remains, showing it to be generally similar to that of *Proetidella fearnsidesi*, though perhaps a little broader and situated slightly farther from the axial furrow. There is insufficient material for the erection of a new species, though the specimen is probably specifically distinct from *P. fearnsidesi*.

Horizon and locality. Marshbrookian Stage, *Dalmanella unguis* Zone, about 350 yards north-west of the road bridge situated 350 yards south-west of Hatton, near Acton Scott.

Family Remopleurididae Hawle & Corda, 1847

Genus ***REMOPLEURIDES*** Portlock, 1843

Type species. *Remopleurides colbii* Portlock by subsequent designation of Miller (1889 : 565–566).

Remopleurides warburgae sp. nov.

(Pl. 46, figs. 1, 2)

1958. *Remopleurides* sp. nov., Dean, p. 224.

Diagnosis. Glabella slightly broader than long, broadest posteriorly, narrowing frontally. Glabellar tongue strongly convex, steeply downturned, equal to about half breadth of glabella. Palpebral lobes flattened, narrowing frontally. Three pairs of equispaced glabellar furrows show through test as black lines. Test mainly smooth.

Description. The glabella is moderately convex longitudinally and transversely, almost as long as broad, its greatest breadth occurring to the rear of centre of the main body. The anterior portion of the glabella is convex, including the glabellar tongue, which is strongly arched downwards. The glabellar tongue is about twice

as broad as long, its breadth half that of the glabella, and the lateral margins converge slightly towards the almost straight anterior margin. Strong palpebral furrows delimit the palpebral lobes, which narrow frontally and continue forwards as narrow rims to the anterolateral angles of the glabellar tongue. Three pairs of equidistant, parallel, glabellar furrows are present, their position indicated by poorly visible black lines showing through the test ; the first pair is shorter (*tr.*) than the second and third pairs, which are of almost equal length. The glabellar furrows curve gently backwards from near the palpebral furrows so as to leave an unfurrowed band extending along the axis of the glabella and occupying about one-fifth of the maximum breadth. The occipital furrow is deeply incised and transversely straight. The occipital ring is moderately convex both longitudinally and transversely, but in the holotype the distal parts are not wholly preserved. The surface of the cranidium is smooth except for the occipital ring, palpebral lobes and anterior portion of the glabellar tongue, all of which are ornamented with fine, slightly-raised, anastomosing ridges, sometimes forming a Bertillon pattern.

The hypostoma, thorax and pygidium are not known (but see later).

Horizon and localities. The type-material was collected from grey mudstones in the uppermost third of the Actonian Stage in the north bank of the River Onny, 87 feet east of the junction of the river with Batch Gutter. The same species occurs also in the Actonian Stage at Acton Scott, and, perhaps, near Hatton.

Holotype. BM. In. 49751 (Pl. 46, figs, 1, 2).

Discussion. In plan the glabella of *Remopleurides warburgae* most resembles *R. dalecarlicus* Holm MS., described and figured by Warburg (1925 : 88, pl. 1, figs. 7, 8) from the Upper *Leptaena* Limestone of Sweden and therefore younger than the Shropshire species ; the Swedish form also has a smooth test but possesses a narrower, more convex, glabellar tongue.

Remopleurides latus Olin ***onniensis*** subsp. nov.

(Pl. 46, figs. 4, 5)

Diagnosis. Glabella broader than long, with main body transversely ovate in plan. Glabellar tongue equal in breadth to half that of glabella, strongly declined frontally, its anterior margin transversely truncated and indented medially. Palpebral lobes narrow forwards, forming rim along sides of anterior glabellar tongue. Three pairs glabellar furrows visible through test as dark lines.

Description. The glabella is moderately convex both longitudinally and transversely, its length (*sag.*) equal to three-quarters the maximum breadth, which occurs midway between the occipital furrow and the base of the glabellar tongue. The latter is longitudinally convex, less so transversely, and strongly arched down frontally, its breadth half that of the glabella. Apart from a small median indentation the anterior margin of the glabellar tongue is transversely straight, meeting the anterolateral margins at right-angles. Three pairs of equidistant glabellar furrows are present, showing through the test as poorly-discernible dark lines, and not impressed upon the outer surface of the test. The first pair is shorter (*tr.*) than the second and third pairs which extend distally almost to the palpebral furrows ; the

third pair curves backwards a little more strongly than the first and second pairs, which are almost parallel to one another. All three pairs of furrows curve gently backwards and extend adaxially from the lateral margins so as to leave an unmarked band, running down the centre of the glabella and about one-fifth the breadth of the latter. The palpebral lobes, which narrow frontally and are separated from the main body of the glabella by deeply-incised palpebral furrows, continue forwards in the form of a much attenuated rim as far as the anterolateral angles of the glabellar tongue. The occipital ring is only slightly convex longitudinally, and becomes shorter (*exsag.*) laterally. The surface of the test of the glabellar tongue and occipital ring is ornamented with fine, anastomosing, raised ridges arranged parallel to the anterior margin, but the remainder of the test is smooth. The hypostoma, thorax and pygidium are not known (but see later).

Horizon and localities. The uppermost third of the Actonian Stage, exposed in the north bank of the River Onny, 87 feet east of the junction of the river with Batch Gutter. The type-material was found in a band of shelly débris, about 3 inches thick, containing also *Remopleurides warburgae*, *Tretaspis*, *Chasmops*, *Sampo* and *Onniella*. The species is not known with certainty elsewhere, but fragments possibly belonging to it have been found in the Actonian Stage at Acton Scott.

Holotype. BM. In. 49750 (Pl. 46, figs. 4, 5).

Paratype. BM. In. 49762.

Discussion. The new subspecies is generally similar to *Remopleurides latus* (Olin, 1906, pl. 2, figs. 5*a*, *b*) from the Chasmops Series of Scania, particularly in the form of the posterior half of the glabella, but the convexity of the glabella is greater and the glabellar tongue is both longer and broader. *R. latus kullsbergensis* (Warburg, 1925 : 83, pl. 1, figs. 1–6) has more distinct glabellar furrows as well as a smaller, narrower glabellar tongue than the Shropshire subspecies, though the two are probably of generally similar age, whilst *R. latus* var. *granensis* (Størmer, 1945 : 408, pl. 4, fig. 4), from a slightly higher horizon, differs in possessing a narrower glabellar tongue, and a test which is described as having a completely smooth surface. *R. validus* (Thorslund, 1940, pl. 7, figs. 1–9), from the Lower Chasmops Limestone, shows a glabella of generally similar outline to that of the new subspecies but the glabellar tongue is both narrower and less well differentiated from the main body of the glabella. *R. wimani* (Thorslund, 1940 : 135, pl. 7, fig. 10), though of an age generally comparable to that of *R. latus onniensis*, exhibits a much narrower glabellar tongue and the main body of the glabella is both narrower and more convergent forwards.

Remopleurides sp.

(Pl. 46, figs. 3, 7)

At the type-locality of *Remopleurides warburgae* and *R. latus onniensis*, isolated fragments of *Remopleurides* have been found in abundance in a fossiliferous band of shelly mudstone about 3 inches thick. There appears to have been some sorting of the trilobite remains and although librigenae and thoracic segments are not uncommon, no pygidium has yet been found. Two typical specimens are figured here, but it has not yet been possible to assign either to a definite species.

The main part of the librigena is subtriangular in outline (Pl. 46, fig. 3), slightly convex, and arched down laterally. A long, stout spine is developed, the whole of which is not preserved ; as in the case of *Remopleurides latus kullsbergensis* (Warburg, 1925 : 84, fig. 15), this is not developed from the true genal angle but arises from a position just in front of it. The posterior portion of the librigena stands at a somewhat lower level than the remainder, from which it is separated by a strong transverse furrow. This part of the librigena terminates posterolaterally in a short, blunt, librigenal spine, separated by a well-defined notch from the long anterior spine, but the proximal end is marked by a rounded, flange-like notch, the function of which is to provide articulation with the fulcral process of the first thoracic segment. The surface of the test is ornamented with several well-developed, anastomosing ridges, subparallel to the distal margin of the librigena as far as the genal angle, but transverse in direction near the fulcral notch. The librigena strongly resembles that of *R. latus kullsbergensis* and may belong to the allied *R. latus onniensis*. It also recalls, but is shorter and broader than, one figured by Thorslund (1940, pl. 7, fig. 16) and referred by him to *R.* cf. *latus* Olin.

In addition to numerous isolated thoracic segments, a group of six articulated segments has been found (Pl. 46, fig. 7). The axial rings are gently convex longitudinally and transversely, the breadth at least four times the length (*sag.*), excluding the articulating half-ring. Apart from a small, central portion the posterior margin of each axial ring is serrated, particularly distally, up to six tooth-like spines being visible on the lateral half of each ring ; similar structures are developed on the axial rings of *Remopleurides colbii* Portlock (Whittington, 1950, pl. 70, figs. 1, 4). The side-lobes are narrow, with flattened pleurae terminating in short (*exsag.*), broad, backwardly-directed pleural points. The pleural furrows are curved, deep, directed distally towards, but not attaining, the pleural points. Just outside the axial furrow the anterior margin of each pleura is thickened markedly to form a conspicuous, tooth-like, fulcral process, the posterior margin being indented to give a corresponding, flange-like, articulating socket. The test is ornamented with fine raised ridges distributed more or less parallel to the margins of each segment and tending to converge at the pleural points.

Horizon and locality. Actonian Stage, north bank of the River Onny, 87 feet east of its junction with Batch Gutter.

Genus ***REMOPLEURELLA*** nov.

Diagnosis. Cranidium of typical remopleuridid outline, the main body only gently convex, both longitudinally and transversely, with three pairs of deeply-incised glabellar furrows, those of the first pair noticeably shorter (*tr.*) than those of the other two pairs. Surface of test with conspicuous pattern of subconcentric, thin, raised lines. Librigenae narrow with librigenal spines arising from the genal angles ; posterior margin entire. Hypostoma as long as, or slightly longer than, broad, with transversely straight anterior and posterior borders. Median body suboval, gently convex, with pair of oval areas converging backwards medially ; small anterior lobe, sometimes produced to form short spine, delimited by broad,

curved median furrow, convex backwards. Thorax incompletely known. Pygidium unknown.

Robergiella, type-species *R. sagittalis*, from the Edinburg Limestone of Virginia (Whittington, 1959 : 431, pl. 6, figs. 16–33), may be related to *Remopleurella*, which it resembles in the depressed glabellar form, with three incised pairs of glabellar furrows. *Robergiella* differs, however, in having a larger glabellar tongue which expands forwards, as well as considerably broader librigenae, each of which carries a pronounced notch at the base of the librigenal spine.

TYPE SPECIES. *Remopleurides burmeisteri* Bancroft, 1949.

DISTRIBUTION. Known with certainty from the Onnian Stage of the type Caradoc Series in south Shropshire. Probably occurs also in the higher Caradoc strata of southern Norway.

Remopleurella burmeisteri (Bancroft)

(Pl. 45, fig. 2 ; Pl. 46, figs. 6, 8, 9, 11, 12)

1945. *Remopleurides* (? *Caphyra*) sp., Lamont, p. 118.
1949. *Remopleurides burmeisteri* Bancroft, p. 300, pl. 10, figs. 19, 20.
1958. *Remopleurides burneisteri* Bancroft : Dean, pp. 213, 225.

Bancroft's original description covered the cranidium, librigenae and thorax (*pars*), and little need be added. Most known cranidia, including one of the syntypes, are slightly flattened with the glabellar tongue apparently arched down only slightly, but occasional specimens show that the plane of the tongue is, in fact, steeply declined frontally, almost at right-angles to the remainder of the glabella. Most of the known specimens are preserved in decalcified mudstones in which the glabellar test is not seen, but one specimen, BM. In. 54772, from the unweathered underlying strata shows the test to have been thin, its dorsal surface, apart from the smooth, deeply-incised glabellar furrows, ornamented by thin, raised, anastomosing ridges forming a Bertillon pattern.

A hypostoma presumed to belong to this species occurs in association with the paratype thorax, and a slightly smaller specimen has recently been collected by Mr. S. F. Morris. The entire hypostoma is as long as, or slightly longer than, wide. The gently convex median body is generally ovate in outline with bluntly terminated anterior and posterior margins, and is circumscribed by a moderately-deep border furrow. The posterior border is apparently continuous with the narrow (*tr.*) lateral border, which is, in turn, continuous with the anterior border. The last-named is transversely straight produced distally to form a pair of anterior wings, separated by rounded lateral notches from the lateral borders. The median body is divided into two unequal parts by a curved median furrow, concave forwards, deepest medially, and shallowing distally. The anterior lobe is small, convex, and specimen In. 56800 shows it thickened medially to produce a small spine. The posterior lobe, occupying about three-quarters of the length of the median body, is traversed longitudinally by a faint groove, a continuation of the median furrow, which narrows backwards and ends at the posterior border. The posterior lobe is thus divided so as to form what Whittington (1950 : 541) has described as two oval

areas, their long axes convergent backwards. Fragments of the test show it to be thin, its lower surface covered by subconcentric, thin, raised ridges.

LECTOTYPE, here chosen. BM. In. 42106 (Pl. 46, fig. 11).

PARATYPES. BM. In. 42098 (Pl. 46, fig. 6) ; BM. In. 49561 (Pl. 46, figs. 8, 12).

HORIZONS AND LOCALITIES. The earliest known occurrence of the species is a single cranidium, BM. In. 54772, from the Onnian Stage, *Onnia gracilis* Zone, by the north bank of the River Onny about 100 yards east of the junction of the river with Batch Gutter. All the other known specimens, including the types, are from the *Onnia superba* Zone in the north bank of the Onny, 720 yards west-south-west of Wistanstow Church.

DISCUSSION. *Remopleurella burmeisteri* appears to belong to a group of remopleuridid trilobites which, although they have received little attention, are not uncommon in at least the Upper Chasmops Limestone, Stage 4bδ, of southern Norway, and probably occur also in parts of Sweden. Several such are housed in the Paleontologisk Institut, Oslo, where some have been labelled as '*Remopleurides* cf. *radians*", the type-species of *Amphitryon* Hawle & Corda, but they cannot be assigned to the latter genus and probably belong to *Remopleurella*.

Family THYSANOPELTIDAE Hawle & Corda, 1847

Genus ***EOBRONTEUS*** Reed, 1928

TYPE SPECIES. *Entomostracites laticauda* Wahlenberg, 1818 by original designation of Reed (1928 : 58, 75).

Eobronteus? sp.

(Plate 46, fig. 10)

1958. *Eobronteus* ? sp., Dean, p. 224.

Three fragmentary specimens housed in the Sedgwick Museum are the only representatives of this trilobite family found in south Shropshire, and the best preserved of these is now figured. The specimen comprises an almost complete thorax, the full number of thoracic segments not being visible, together with a fragmentary cephalon, which partly obscures the thorax, and an incomplete pygidium. The genus *Eobronteus* has been examined in detail by Sinclair (1949) who has figured or noted all the known species. None of these agrees wholly with the Shropshire species, which may be new, but a detailed description must await the collection of better-preserved material.

HORIZON AND LOCALITY. Onnian Stage, *Onnia superba* Zone, north bank of the River Onny, 720 yards west-south-west of Wistanstow Church.

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